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GEORGE REID
Editor

CONTENTS

Special Features

Duo-Sol Plant in Operation 369

Prevent Accidents 375
J. C. Albright

This Business of Being Safe (Pictures) 378

Factors Affecting Gum Stability of Gasoline 381
T. L. McNamara

Gasoline Plant and Debutanizer 386

Theoretical Considerations of Fractional Distillation and Condensation 390
M. Frenc

Automatic Machinery for Canning Oil 394

Production of Lubricants from Osage Crude 395

Economies in Grease Making 400

Regular Departments

Science and Technology 32a

The Month in Review 47a

Plant Activities 52a

New Equipment for the Modern Plant 55a

Items About Manufacturers 59a

Catalogs and Bulletins 61a

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Refinery Gases Marketing of refinery gases to city gas manufacturers has steadily been gaining headway during recent years and many plants in the north and east located adjacent to large cities have found it profitable to develop this market; both to the advantage and profit of the refiner and the gas manufacturer. Where a few years ago only a few refining concerns had engaged in this activity there are now over a score of plants which sell their surplus gases to various industrial and community consumers.

The potential source of city gas supply, however, has not yet been fully realized by either the refiner nor to consumer of such a by-product. Conditions at present are more favorable for the utilization of petroleum refinery gases by public utility systems than ever before because of continued interchange of experiences and technical information. The problems of mixing, handling, and control of purchased gas have been solved. Some companies have had much success in handling mixtures of coke oven gas, refinery gas, and water gas or producer gas, or refinery gas, coke oven gas and natural gas, or in fact practically any type of fuel gas mixture. Where refineries are located near cities, as the greater number of the larger plants are, the logical consumer of its gaseous by-products is the city. The mechanical and technical problems of transportation, mixing, utilization and distributing have been worked out and perfected to the end that a little salesmanship on the part of the refining concern is all that is necessary to market these gases profitably. Less valuable fuels are usually present at the refinery.

Prevent Accidents The old adage "familiarity breeds contempt" is as applicable to safety problems in the oil refining industry and natural gasoline manufacturing industry as to any other business or profession, and when a group of men become forgetful of the hazards involved in any particular branch of industry they become careless and accidents are certain to happen because of this attitude. The other important factor in control of accident frequency consists of adequate training and sufficient safeguards in the plant. J. C. Albright has contributed an article in the form of a series of notes and suggestions dealing with this important problem, and his discussion is based on his years of practical experience in the industry and on studies with a number of safety engineers in the Mid-Continent refining and gasoline manufacturing area. Page 375.

Gum Stability T. L. McNamara, chief chemist, Root Refining Company, El Dorado, Arkansas, in this issue contributes a valuable discussion of factors affecting the gum stabilities of gasolines. His study and research has brought him to conclude that doctor treating a freshly distilled gasoline lowers its induction period; fresh doctor will reduce the induction period to a greater extent than reclaimed doctor, and in the latter case the induction period of the untreated sample may not be greatly different from that of the treated sample; blending straight-run gasoline with cracked gasoline is not an effective means of raising the induction period; sulfur in small amounts will not appreciably affect the induction period, and the relative efficiencies of gum inhibitors vary for different gasoline. Page 381.

Conditions Improve During September the already excellent statistical position of the petroleum industry continued to improve. Outstanding were reductions in both crude oil and gasoline stocks. Crude stocks now are 8,500,000 barrels below two months ago. Gasoline stocks are 13,000,000 barrels below the level of six months ago. It was the third consecutive monthly decrease registered by crude stocks and the sixth for gasoline.

It would appear from these facts that the industry should be in an excellent financial position, but such is not the case. Refined product prices sagged during September despite stock encouragement. Off hand, this situation would seem unreasonable, but there is ample cause.

Market weakness was due to disorderly conditions in East Texas, where gasoline, made from hot crude, was offered in large volume at distress prices. Hot oil output in the field is estimated to have averaged between 85,000 and 100,000 barrels daily in September, which together with 91,127 barrels daily excess production over allowables means the industry took care of at least 175,000 barrels per day more than premilinary demands would indicate as a desirable recovery.

It is very encouraging that crude and gasoline stocks continued to decrease in face of the exceptionally excessive production. Such a situation cannot, in the long run, mean anything but better times within the industry, but, in the meantime, it is exceedingly regrettable that the continued disturbing hot oil situation is keeping the industry from realizing its deserved hope for better profits, which would be the immediate result should all hot oil be eliminated from the market.

Duo-Sol Plant *Now in Operation*

SOCONY-Vacuum Oil Company, Inc., began operation of its Paulsboro, New Jersey, Duo-Sol plant during 1934. This is the first of the four Duo-Sol installations, which have been reported as under construction, to start actual processing of oil.

Officials of Socony-Vacuum Oil Company, Inc., state that they are well pleased with results and that a very satisfactory grade of lubricating oil is being produced.

The particular advantages of the lubricating oils manufactured by this process are their high viscosity indices, low carbon residues, and resistance to oxidation. These qualities make the oils particularly suitable for the modern high speed, high temperature, close clearance motors.

The plant as shown on the accompanying illustrations consists essentially of an extraction system in which the charging stock is separated into its paraffinic and naphthenic constituents by the use of solvents which will selectively dissolve these two constituents, and a double solvent recovery system in which the solvents, propane and selecto, are recovered from the paraffinic and naphthenic oils.

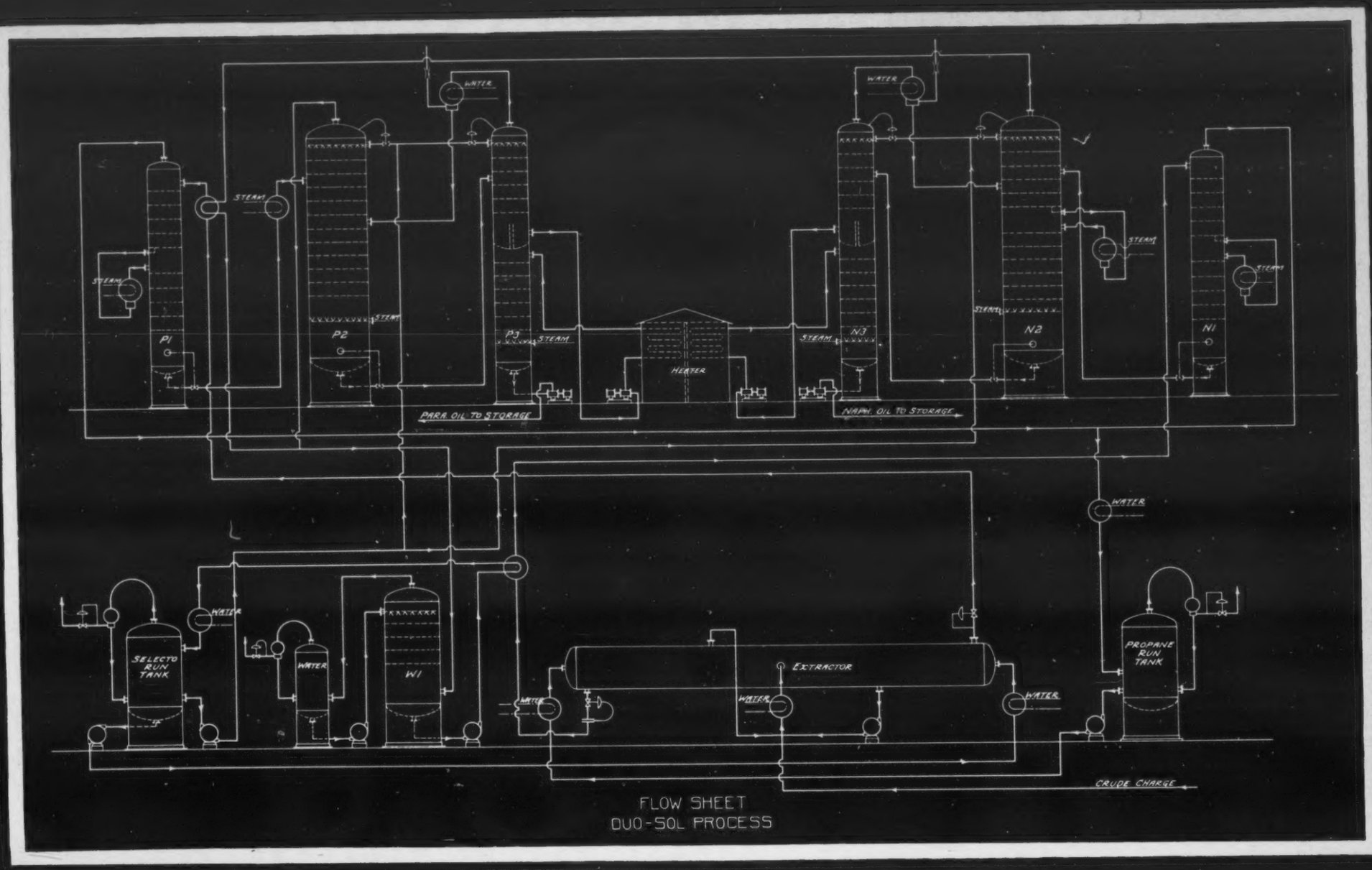
The extraction system has nine mixing and settling compartments. This is one more than the number required, and the pumps and piping are so arranged that any one compartment at a time can be by-passed for repairs to pumps, etc. A description of its operation follows.

The charging stock is mixed with the upper or propane layer from compartment number 2, and the lower or selecto layer from compartment number 4. The mixture is cooled to the operating temperature of about 80° F., and is fed into compartment number 3 for settling and separation. Thus the charge at its point of entrance into the system is dissolved and is separated into two layers. The upper or propane layer, containing most of the paraffinic oil, advances through compartments numbers 4, 5, 6, 7, 8, and 9, while the lower or selecto layer, containing most of the naphthenic oil and asphalt, goes through compartments 2 and 1.

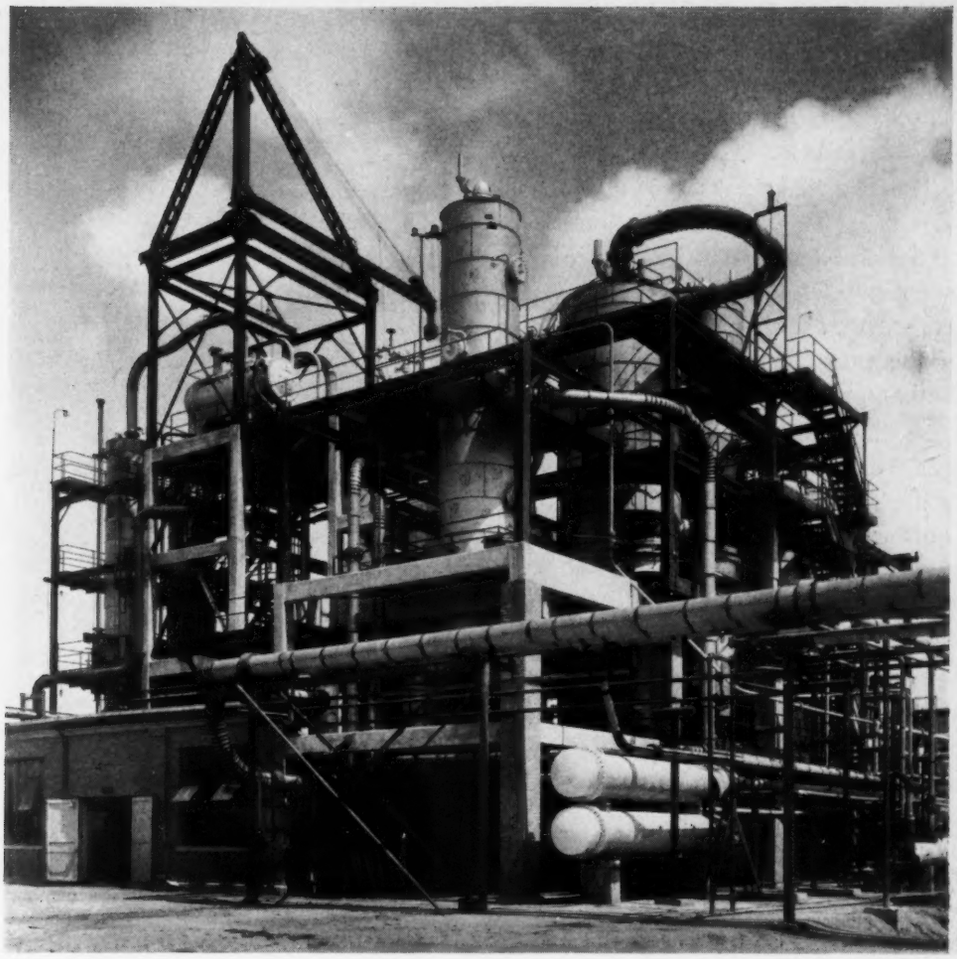
Each of the two layers into which the charge has been divided at the point of entrance undergoes a solvent extraction, the paraffinic propane layer with selecto in compartments 4 to 9, the naphthenic selecto layer with propane in compartments 2 and 1. It is from this double extraction with two different solvents, one selective for paraffinic oils, the other selective for naphthenic oils, that the process takes its name, "Duo-Sol."

The upper, or propane layer from compartment number 9 is the finished paraffinic oil, mixed with solvents. The selecto enters compartment number 9 with the propane layer from compartment number 8 and is advanced successively through the system to the feed compartment. Since the bulk of the naphthenic oils were extracted at the feed compartment the clean up of the paraffinic propane layer is very thorough and a light colored high grade paraffinic oil is produced.

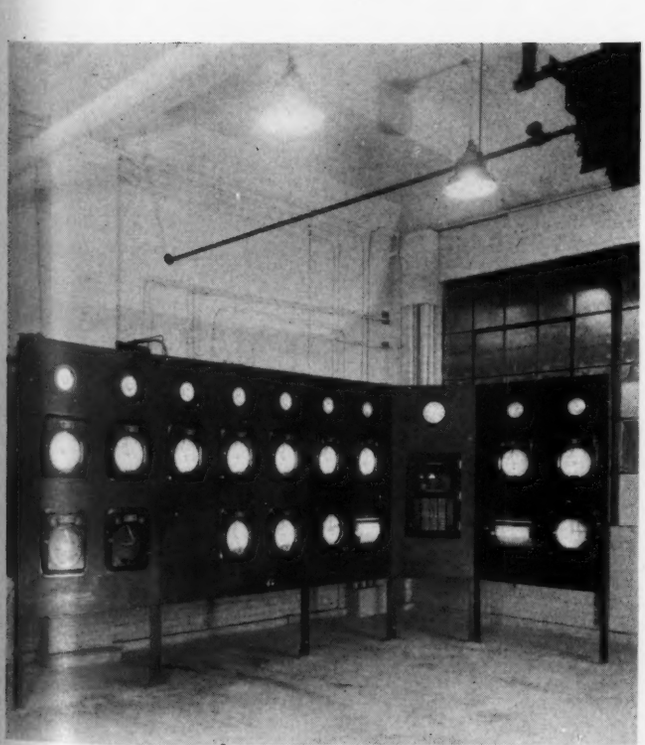
The lower or selecto layer from compartment number 1 contains the naphthenic oil and asphalt, mixed with solvents. The propane enters compartment number 1 with the lower layer from compartment number 2, dissolves from that layer a very considerable quantity of paraffinic oil, and is advanced to compartment number 2. In this compartment it is mixed with the lower



FLOW SHEET
DUO-SOL PROCESS



Towers, exchangers and condensers of solvent recovery system. Control room is shown at left, and below, and interior of control room



layer from the feed compartment, and then with the feed in number 3. This two stage extraction of the selecto layer from the feed compartment with propane is responsible for the high yields obtained by the process. Much desirable lubricating oil is recovered which otherwise would be lost as tar. Moreover, this latter extraction permits the use of a sufficient volume of selecto to remove all undesirable materials from the paraffinic oil with minimum loss of good lubricating oil.

The double extraction with selecto carrying naphthenic oils toward the feed compartment and propane carrying paraffinic oils from the other end back into the feed compartment may be compared with a distillation operation. The more reboiling at the base of a tower and the more reflux at the top, the sharper the separation will be. Likewise any desired degree of separation desired between naphthenic and asphaltic oils and paraffinic oil can be obtained in a Duo-Sol extractor by varying the relative quantities of solvents used. The separation obtained by Duo-Sol is on the basis of paraffinicity of oils, not on boiling range as is the case of a still and tower, hence the analogy is not exact. However, it illustrates the action resulting from the double extraction.

The quantity of each solvent used, relative to the feed, is varied independently depending on the gravity, paraffinicity, and asphalt content of the charge and

the viscosity index desired for the finished oil. Very asphaltic residues require higher solvent ratios, light distillates the lowest, for a given viscosity index, while high viscosity indices require more solvents than lower viscosity indices.

The two long tanks shown in the photographs, one on either side of the extraction shed, are divided by vertical bulkheads to make the mixing and settling compartments. Bottoms layer pumps and piping, with control valves, are shown in the photograph of the interior of the extraction shed. The feed cooler is shown in the background of the latter.

Mixing of the upper or paraffinic layer advancing from compartment 1 to compartment 9, with the lower or naphthenic layer progressing in the reverse direction is effected by nozzle action at the entrance to each compartment. The lower layer is pumped, the upper layer advances because of pressure drop between compartments.

The paraffinic layer contains most of the propane and some selecto. The naphthenic layer contains most of the selecto, with some propane. Hence both must undergo the same processing for solvent removal, although the quantities removed in each case differ considerably.

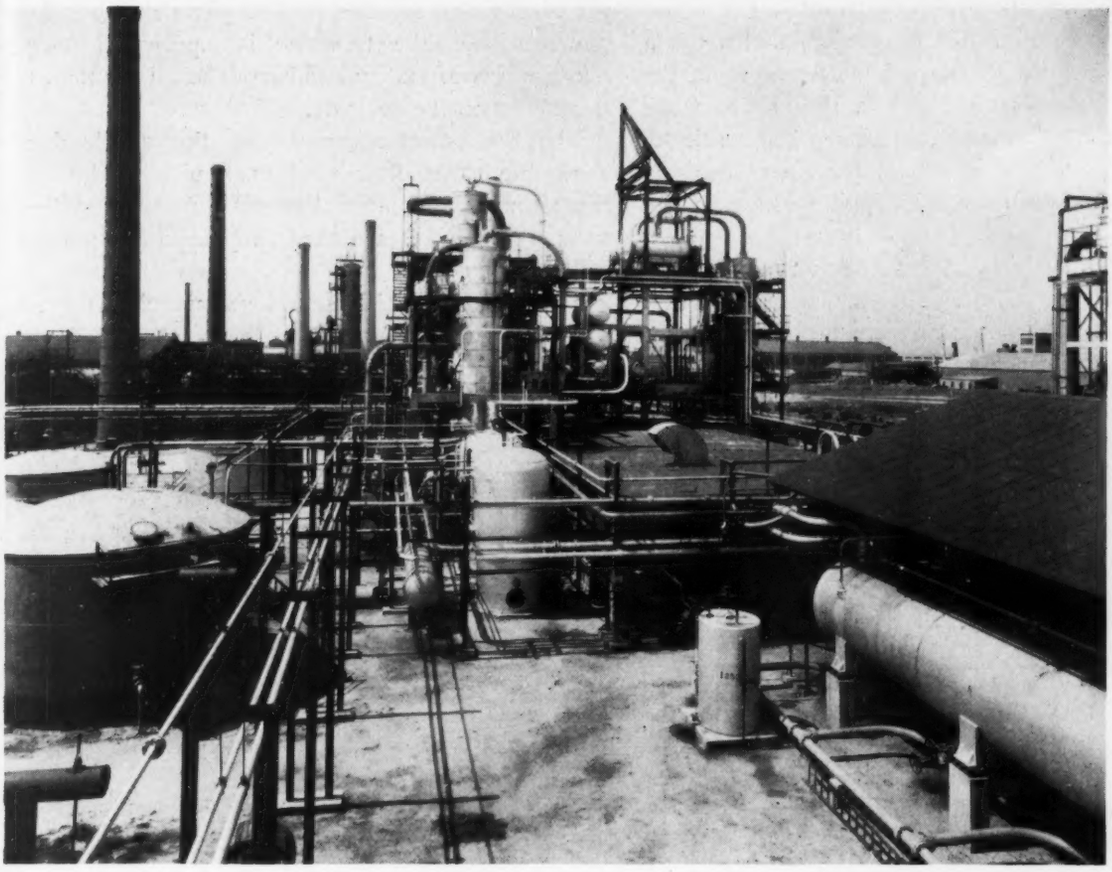
The first step in solvent recovery for both paraffinic and naphthenic layers from the extraction system is the separation of propane. Since a sufficient quantity of high pressure steam is available at the Paulsboro refinery for heating requirements it was decided to do this in two flashes. The first is a flash at about 230 pounds pressure, under which pressure most of the propane is vaporized and then condensed in a water cooled condenser, common to both paraffinic and naphthenic systems. The second flash is at 50 pounds for propane stripping. The vapors from the second flash of each layer are compressed together to condenser pressure and enter the vapor line to the condenser with the vapors from both high pressure flash towers. Condensed propane returns to the work tank for further use.

The next step in each case is the removal of selecto. In order to utilize steam heat this is also done in two flashes, the first in steam heated towers at atmospheric pressure, the second in towers heated by a small double pipe still and carried under about 26 inches of vacuum with steam stripping at the bases of the towers.

The selecto vapors from the naphthenic layer steam heated tower, which comprise the bulk of the selecto, pass to an exchanger where their latent heat is utilized to preheat the paraffinic layer on its way to the first propane flash.

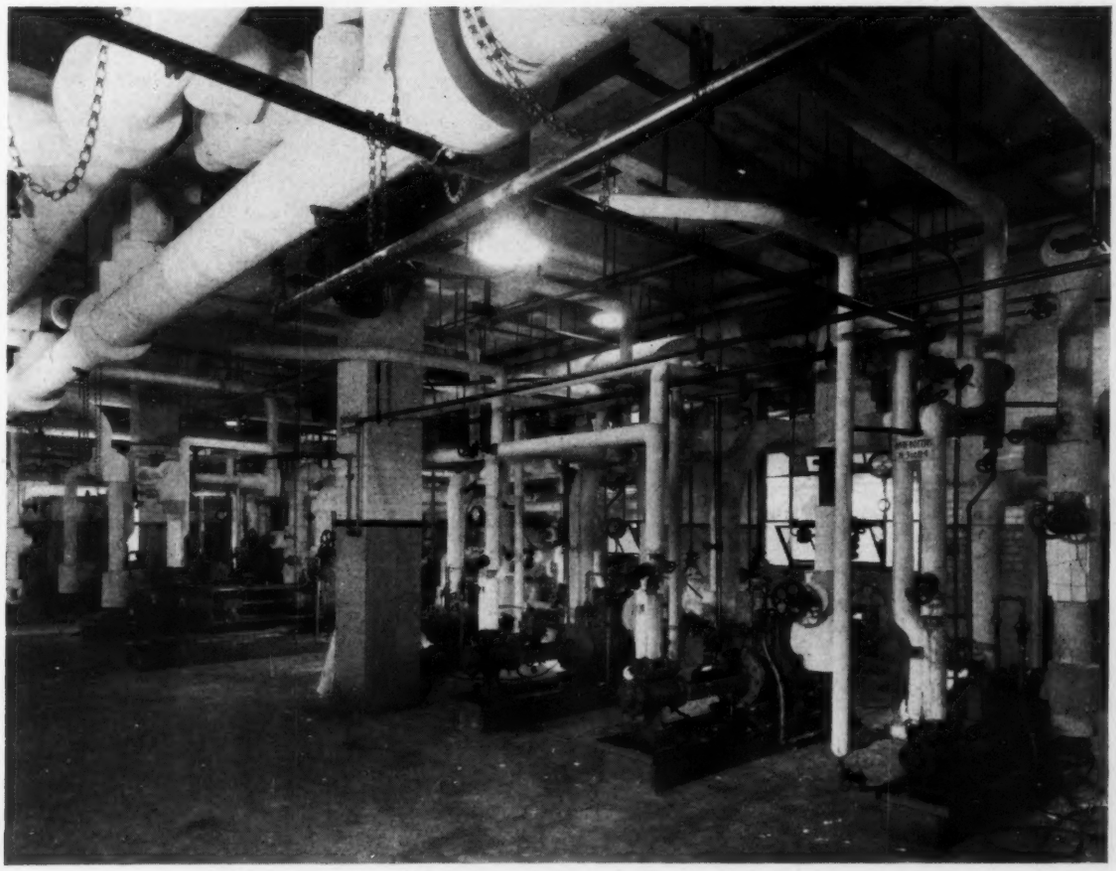
The vapors and condensate from this exchanger, the vapors from the steam heated paraffinic selecto tower, and the condensates from both of the vacuum strippers

Interior of extraction shed, showing naphthenic layer pumps and piping. Settling tanks on right and left



Extraction shed on right, pump house and solvent recovery in center

Interior of pump house



are all collected in a selecto drying tower. The liquid selecto from the base of this tower passes through a heat exchanger against the naphthenic layer from the extractors, through a cooler, and to the selecto work tank. The overhead, steam containing some selecto, is condensed, is reboiled in a heat exchanger by high pressure steam, and serves as stripping steam in the vacuum towers.

The solvent removal is very effective and only traces of selecto are left in the oils. The final trace of selecto is removed from the paraffinic oil in the subsequent dewaxing and clay filtration, leaving the finished oil solvent-free.

Solvent losses are very small, so small in fact that exact measurement of losses has been impossible to date.

Photographs show several views of the solvent recovery system.

The Duo-Sol treated oils are filtered in solution by percolation and finished by Sharples dewaxing. No sulphuric acid or other treatment is required. Filter yields average between 20 and 25 barrels of oil per ton of clay, depending on the color desired.

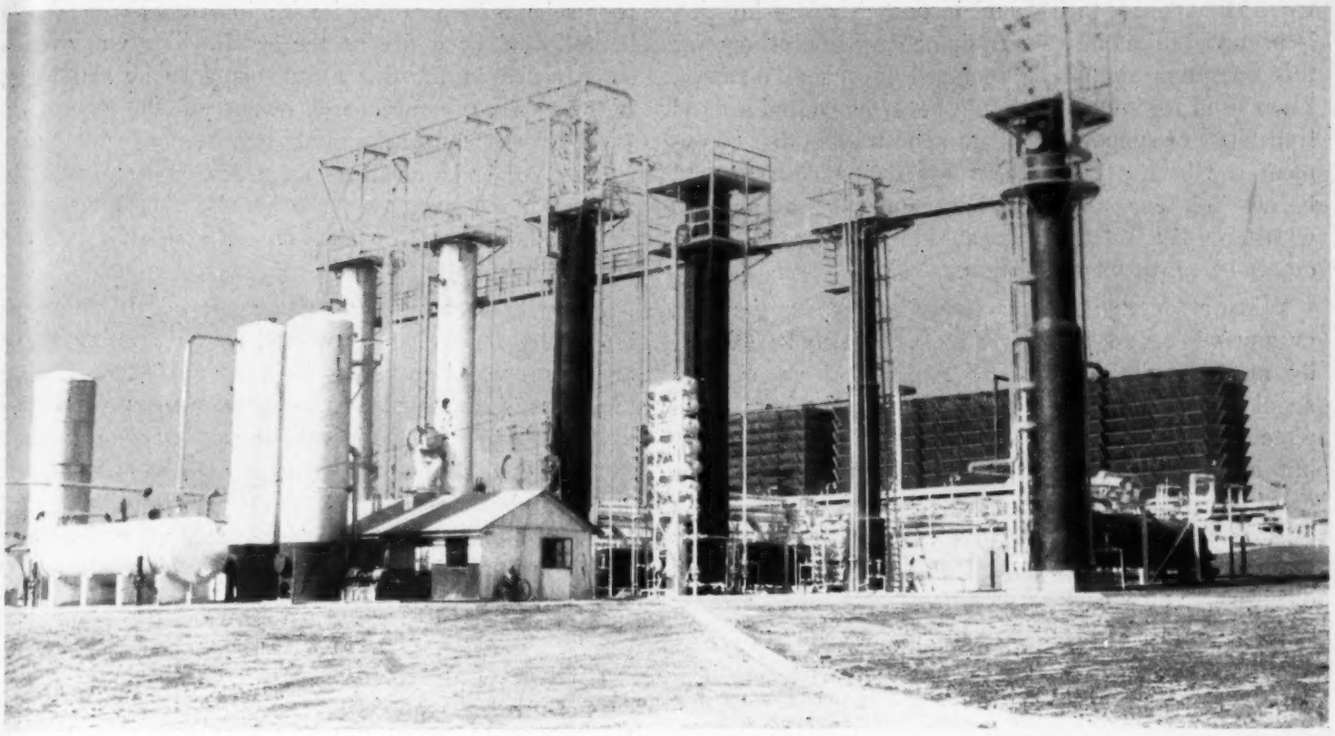
The flow sheet accompanying this article does not show the exact flow used at Paulsboro, but differs therefrom in no essential manner except that the propane removal is shown as accomplished in one tower instead of two.

The following table shows various stocks processed in the Duo-Sol pilot plant of Max B. Miller & Company, Inc., and the products obtained therefrom. Results from the Paulsboro plant and the pilot plant are in close agreement, according to statements made by officials of Socony-Vacuum Oil Company, Inc. A greater variety of charging stocks has been processed in the pilot plant than in the Paulsboro plant, hence the use of the pilot plant results.

Yields and Characteristics of Duo-Sol Paraffinic Oil

OIL SPECIFICATIONS	Tonkawa Marshall Residuum	Mid-Cont. Pipe Line Long Residuum	Oklahoma City Residuum	Deep Sand Reagan Long Residuum	Panhandle Residuum	Salt Flats Residuum	Panhandle Residuum	San Joaquin Distillate
Charging Stock:								
Flash	465°	440°	455°	465°	520°	505°	540°	465°
Gravity A. P. I.	22.3	22.7	23.0	25.0	22.5	18.2	19.8	16.3
Viscosity @ 210°F	100	102	108	97.0	205	295	344	96
V. G. C.	0.8470	0.8440	0.8410	0.8275	0.8345	0.8640	0.8490	0.8970
Paraffinic Oil Before Dewaxing:								
Flash	460°	435°	450°	460°	515°	495°	535°	440°
Gravity A. P. I.	29.5	29.3	30.3	29.5	29.6	29.3	28.3	30.8
Viscosity @ 210°F.	63.5	68.2	69	73	104	90	120	53.6
V. G. C.	0.8040	0.8035	0.7960	0.8005	0.7925	0.7970	0.8000	0.7990
Specific Gravity of Separated Naphthenic Fraction	1.047	1.035	1.035	1.032	1.019	1.031	1.039	0.9865
% Yield of Paraffinic Oil Before Dewaxing with Relation to Charge.	75.5	75.8	70	83.4	71.3	56.8	67.6	25.4
Paraffinic Oil After Dewaxing:								
Flash	460°	435°	450°	460°	515°	495°	535°	440°
Gravity A. P. I.	27.8	28.1	28.9	28.7	28.3	27.3	27.4	30.7
Viscosity @ 100°F	585	695	627	775	1372	1380	1600	341
Viscosity @ 210°F	69	74.5	72	79.2	112.4	105.5	123	54.5
V. G. C.	0.8140	0.8100	0.8050	0.8041.	0.8000	0.8086	0.8050	0.8003
V. I.	100	99	103	100	103	95.3	104	95
Color N. P. A. (See Note)	6	8	8	7½	8+	5½	8+	1¾
Cloud	0°	—10°	20°	0°	5°	0°	25°	—0°
Pour	0°	0°	20°	5°	15°	5°	25°	10°
Carbon Residue%	0.20	0.270	0.23	0.24	0.42	0.30	0.627	0.20
Navy Emulsion Test	O.K.	O.K.	O.K.	O.K.	O.K.	O.K.	O.K.	O.K.

NOTE: Color indicated is that produced by Duo-Sol Processing without other treatment.



Adequate safeguards placed on top of fractionators to protect men from falling when cleaning tubes or making other repairs. Phillips Petroleum Company, Borger, Texas

Prevent Accidents . . .

J. C. ALBRIGHT

IT has been stated emphatically by some that all accidents can be prevented, but this is not true because of the many factors involved. A marked reduction in accidents has been made in refineries and natural gasoline plants in the past few years through the efforts of the safety organizations and by the operators of equipment giving more attention to the condition of equipment while it is being used.

Recently apparatus have been adapted to the manufacture of metals so that flaws in plates and welded seams can be determined before being fabricated into refining units. X-ray machines are now available to the manufacturer so that a pressure vessel can be inspected while in place, and if it shows flaws or thinning of sheets, accidents can be prevented by removing the vessel or repairing it.

The owners of refineries and natural gasoline plants have two reasons for prevention of accidents. The first in the minds of most of them is the safety of the personnel in the plant. The second is the preservation of property. Both go hand in hand because when an employee is injured it is probable that some of the equipment may be damaged. Unfortunately the human element is still present, and through over zealous activities of the men, chances are taken that often result in serious injuries to both the men and the equipment.

The old adage "familiarity breeds contempt," is as applicable to refining and natural gasoline manufacture as any other business or profession, and when a group of men become forgetful of the hazards involved in any particular branch of industry, they become careless and accidents are certain to happen because of this attitude.

Formerly in the erection of dephlegmators, towers and fractionator columns, ordinary steel ladders were made on the spot, fitted to the sides of the vessels so that the employee could climb to the top of the tower for making adjustments. After the small rungs proved hazardous in cold weather, especially when ice formed on cold metal. Many times an operator has slipped and was injured by falling. At present no reputable manufacturer of equipment, refiner or manufacturer of natural gasoline will permit ladders to be placed on this class of equipment unless they are provided with baskets so that even when an employee slips, the guards around him will catch him and prevent falling any distance.

When hoisting heavy equipment to place it in position for operating, adequate provisions should be made for double blocks and gin poles. Snubbing lines and guy

wires should be attached and inspected before hoisting is begun. All rubbish or equipment not necessary for this operation should be removed to a safe distance. Lines used for snubbing should never be wound around stanchions or supporting pillars upon which other equipment has been placed. Posts for this purpose should be set in the ground and have sufficient strength to withstand any pull or shock caused by the weight of the object being placed in position.

When a pressure still reaction chamber, fractionator, or any other vessel is taken off stream to be entered by men cleaning or making repairs, all vapor lines should be blocked off. It is not enough that a blind plate has been inserted between the flanges of gates, but before placing them in position, they should be carefully inspected. There have been instances when explosions have occurred with blind plates in flanges with adequate gaskets. One instance could be pointed out in particular where several men were killed because of cracks developing in the plate. After the explosion, every possible situation was looked into, and finally someone picked up the plate and found that crystallization had caused deformation to such an extent that the plate had become ruptured. Sufficient inflammable vapors had leaked through the crack and when contact was made between the oxygen in the air and the extremely hot gas, an explosion occurred.

The introduction of water along with oil that is being processed under high temperature and high pressure has resulted in the destruction of valuable property and the death of men. Blind pockets should never be permitted to be included in the design of any pressure equipment. Water vapor condensing between runs often accumulates in such places and as the unit is brought on stream again, steam is generated with such speed that there is no escape except through rupture of steel plates. An accident of this character happened in a refinery some time ago and resulted in the death of several of the operating force and caused almost total destruction of the plant.

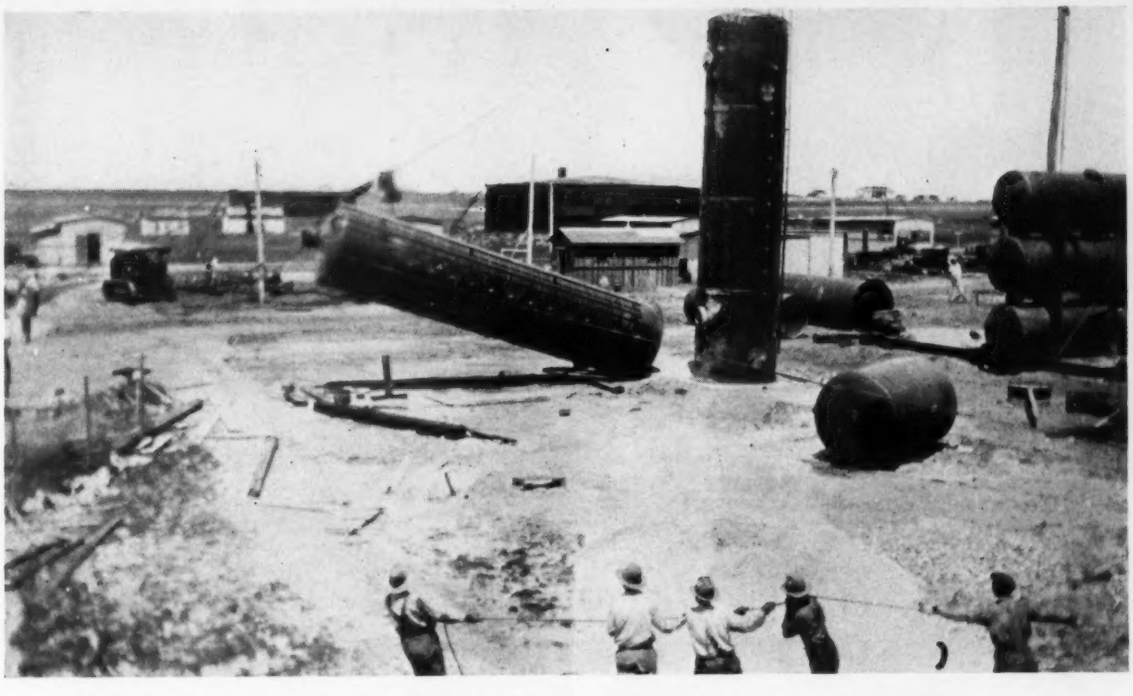
One problem that has not been adequately taken care of is the matter of stuffing boxes on pumps. These should be so arranged that it becomes a simple matter for the "pump doctor," or other employee to remove and replace worn packing. It is human nature to slight a job when it becomes difficult, and many times in repairing packing jobs, an employee has tried to get between two pumps to pack them. Working in a cramped position, and if he cannot remove the worn material with the packing hook, he remarks to himself: "Oh, well, let 'er go. T'ell with it anyway." Then new rings are crammed into the stuffing box upon the remaining old ones. Leaks develop rapidly and the glands are screwed down with a wrench until sufficient pressure is placed upon the packing that the rods begin to score. Volatile liquids escape easily through such packing jobs, and instances have been known where pump rooms have become filled with inflammable vapors to be followed by a fire as the result. The employee is often censured for this attitude and so he should be, but the manufacturer and owner of the equipment "asked for it" when designing or installing such equipment. Accidents resulting from scored rods could be reduced if the pumps were designed with more room at the gland, and were installed on higher foundations and further apart.

Many times accidents have happened to employees by having their clothing wound up on rotating shafts and unprotected couplings between motors or engines and centrifugal pumps or gear driven reciprocating units. Regardless of the care the designer and manufacturer has given to the surface of shafts or couplings, recessing bolts or manufacturing couplings with shell covers, the operator will straddle the shaft or lean over the couplings. Result, wound up clothing and severe pain because of bruised bodies, or death from crushing or flailing against the floor or walls. Some companies have taken the precaution to prevent such accidents by enclosing shafts and couplings in adequate covers, strong enough that an employe, no matter how careless he is, can rest his entire weight upon them without distortion or being caught by the swiftly rotating members of the equipment.

Walkways and elevated platforms should always be provided with hand rails and toe-boards. These should be exceptionally strong and of sufficient height when placed on towers, where overhead tube and shell condensers are located. This is especially advantageous when it becomes necessary for men to clean tubes by boring them out with a drill and a long bit or other tool for the removal of scale. These rails should be inspected regularly. When bolts become loosened or nails drop out, they should be tightened or replaced immediately, for men are certain to lean heavily upon railings, and sometimes sit upon them in a devil-may-care sort of an attitude.

Wrenches have probably caused more minor accidents then any other tool used around the refinery or gasoline plant. They have been dubbed "knuckle busters" because of injured fingers caused by slipping. The trouble is not so much from the design of the wrench as it is from the purchase of cheap tools and from improper use of them. Men are prone to use one wrench for as many different sizes of nuts as he can get the opening to hang onto, but often he is forced to do so by insufficient supply of tools. Enough of adjustable and fixed opening wrenches should be supplied the mechanics so that nuts and tools themselves can be kept in good condition. Of course most plants have a method of some kind by which a check can be made of the tools, but often they are issued from the tool room with dull jaws, cracked openings, broken sockets or bent handles. All of these defects are only inviting accidents to the men when they are forced to use them in this condition.

The carrying of matches, strike-anywhere or safety



Absorbers being erected in Texas Panhandle. Note safe distance of men handling guy lines Phillips Petroleum Company, Carson County, Texas

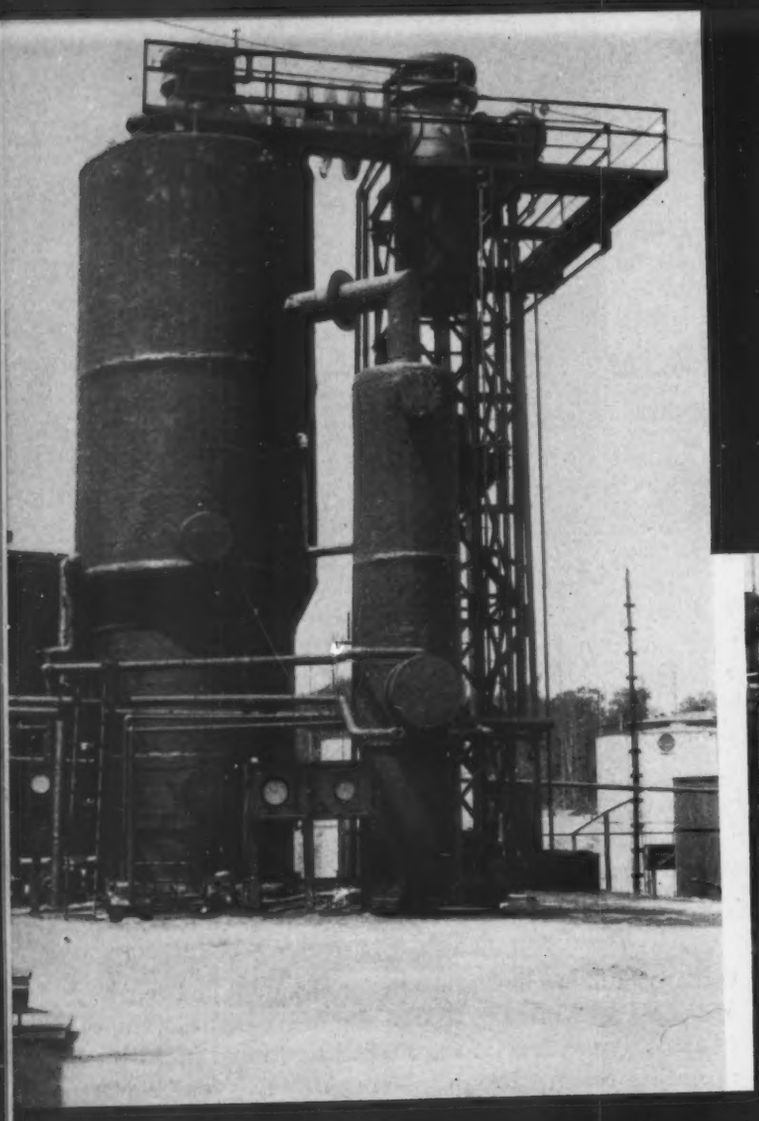
types, has caused many accidents. Often plants have placards and large signs erected warning employees that matches must not be carried in clothing when entering the plant gates. The strike-anywhere kind of match is particularly dangerous. Men who are carrying them in their clothing are apt to lean heavily against some object and ignite them. They are easily dropped from pockets upon concrete floors and when they are stepped upon a sputter comes, then perhaps a sheet of flame. Fires have been caused in numerous instances by men taking a clandestine smoke. This is always done in out-of-the-way places, behind columns and stills, or behind tanks. Men have been known to strike matches on the heads of tanks when repairing gates and manifolds through which volatile and very inflammable liquids have been passing. Result? Fire, explosion, and the undertaker. Little kids going hungry because the pay check has been stopped through the fault of some dumb fool who had to have a smoke.

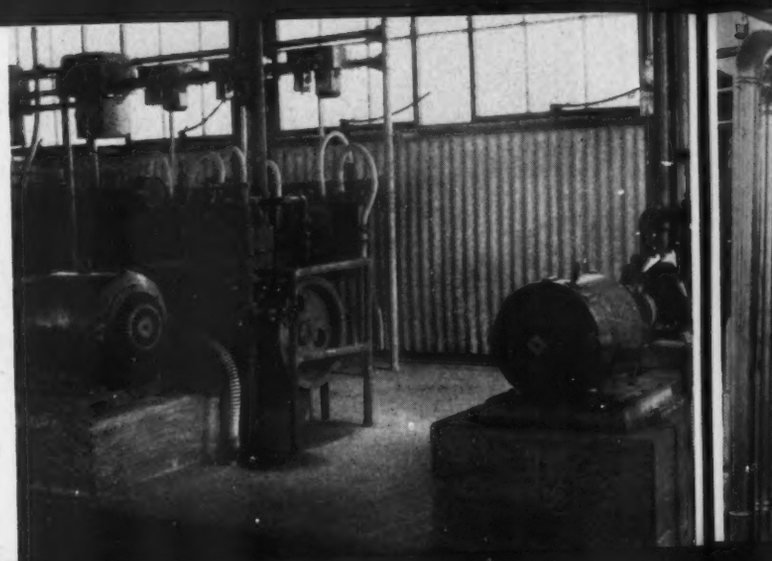
Fires have also been caused because of defective equipment. Usually such equipment that has been operating for a long period after it should have been repaired. A disastrous fire occurred recently in one plant through the failure of a gasoline hose. Liquid and vapor both were blown to a nearby boiler room and were ignited, because of the failure of someone to report the condition of this hose and an order to install a new one. Result? A half million dollars gone up in smoke for the lack of spending 10 or 15 before it happened.

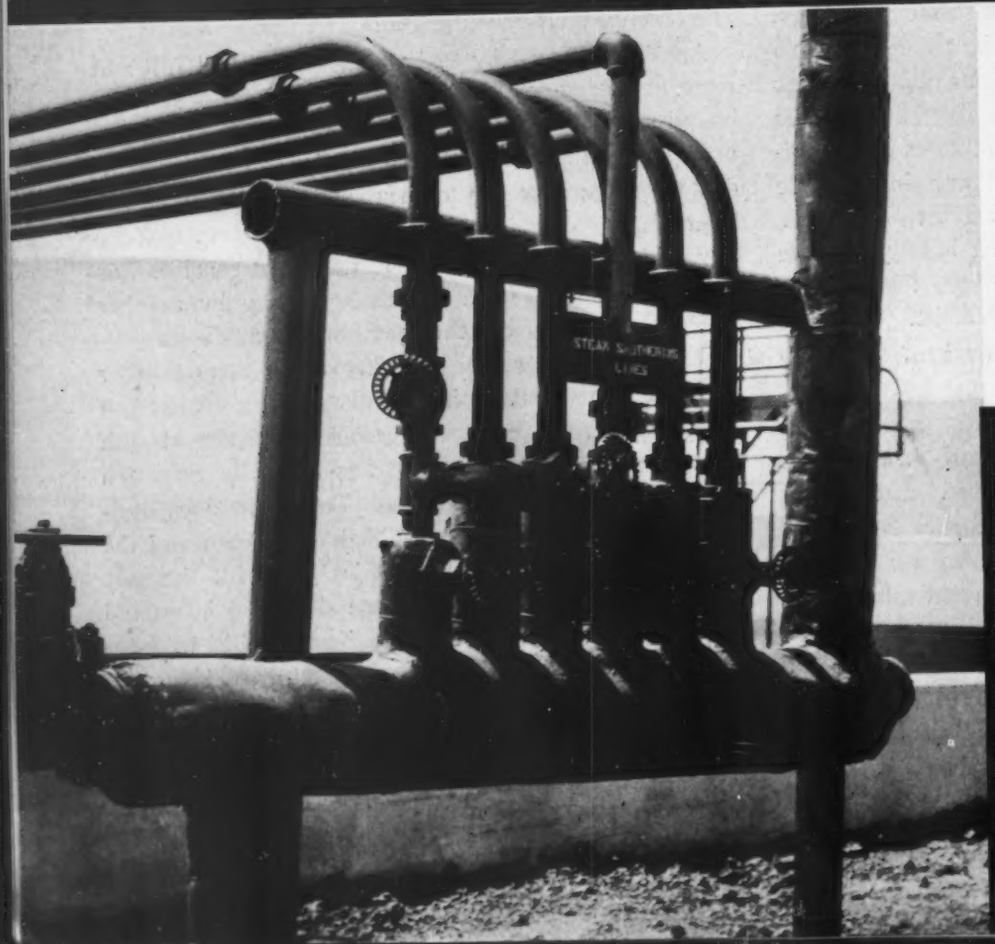
Fires have occurred at pressure stills because the operators wanted to get a few more hours on a particular run before a shut-down for clean-out and repair. Often the executive in charge has demanded that runs of as long duration as can be had be turned in on the operating report. Result? Ruptured tubes and blown headers with fire all over the lot. Are these accidents? Quite likely they are, but such can be prevented by the use of a little judgment on the part of the employe, the executive in charge and the management by demanding that the plant either be maintained in a safe condition or shut down.

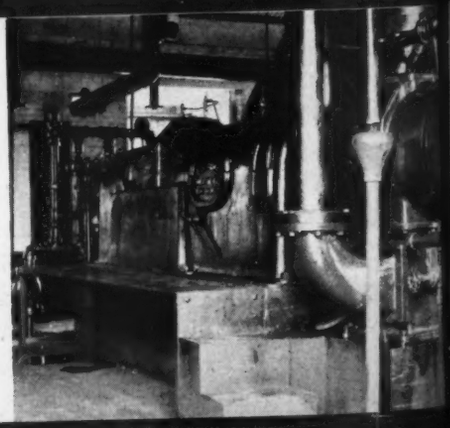
Accidents caused by tanks being filled shell full and more, where vapors are removed by compressors, can be reduced by having sufficient employees to watch these operations and prevent them by switching tanks. Accidents have been known to occur when an employee has been given so many extra duties to perform that he cannot do any of them well. In one plant gasoline was being transferred from a remote battery by another staff of employes, and the operator whose duties consisted of watching the receiving tanks among other things, was given the job of overhauling a loading-out pump. In the meantime he became so engrossed with this extra work that the tank was evidently forgotten and it was filled to overflowing. The vapor lines leading to the engine room were filled with liquid and the compressors began taking in this load with the gas. Fortunately, the engineer was on duty and by-passed the liquid to a drain before serious trouble was encountered. Result? Enough gasoline wasted to hire several men, and a fire averted by the "skin of the teeth."

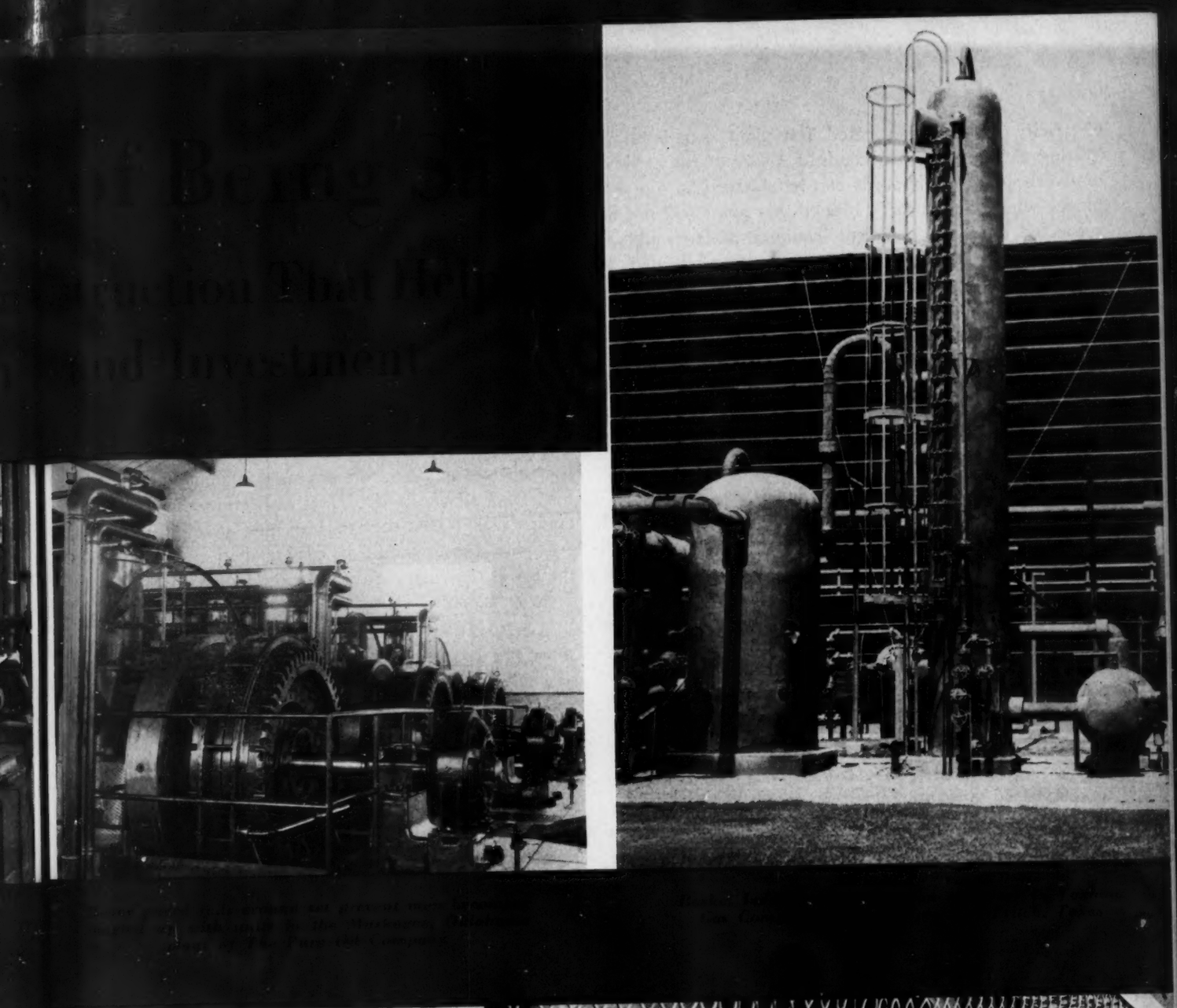
Accidents can be prevented in power rooms where

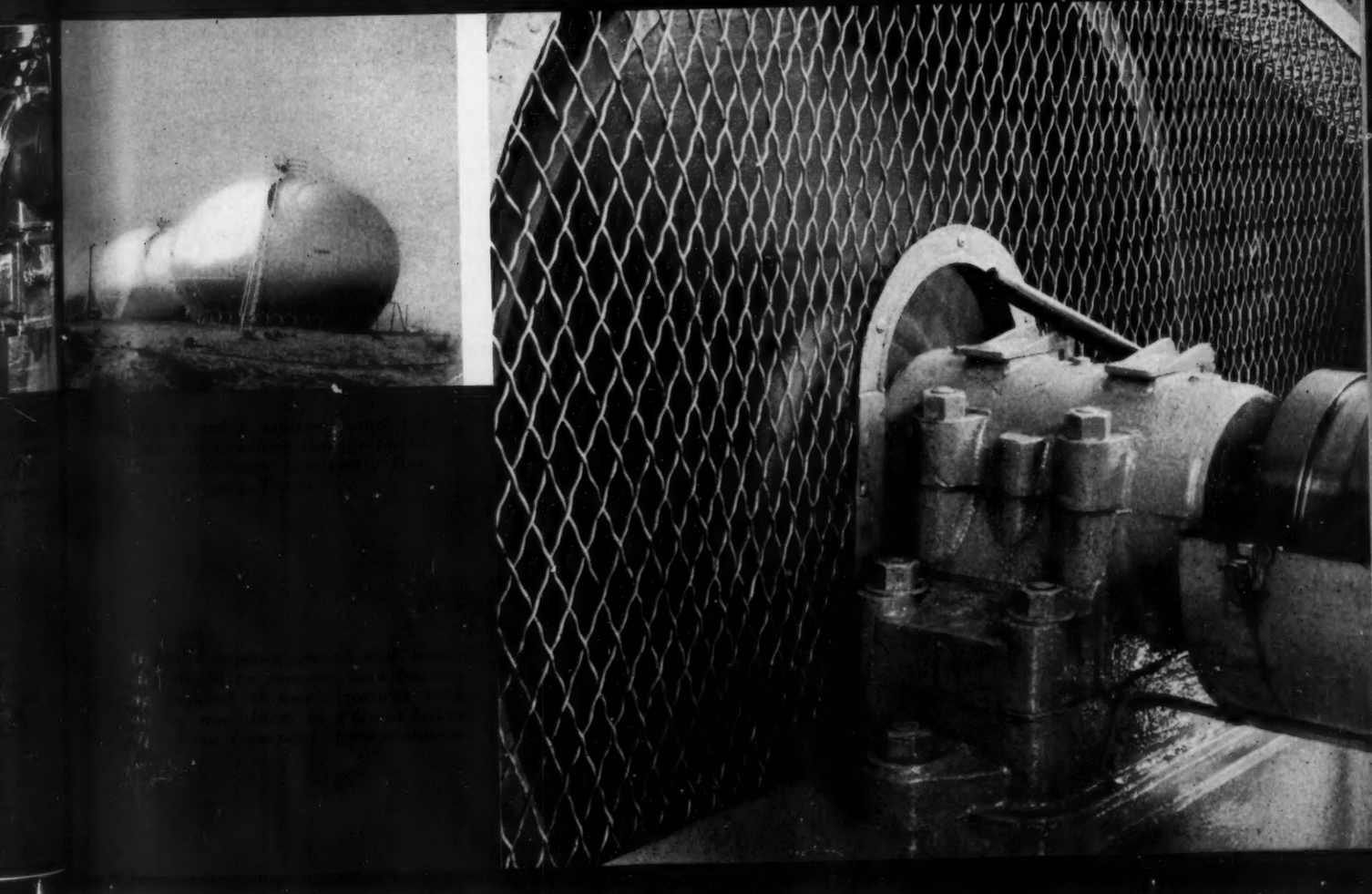





STEAM SUPERHEATER
LINES







electricity is being generated for plant consumption. Wiring can be placed in conduits either in the ground or overhead. Switchboards can be shielded so the employee whose duties carry him to this point will not be subjected to shock. Efficient insulated mats should be placed before the boards, and no one permitted to touch any of the controls except an experienced man. Heavy railings should be placed in such a position that no one can come in contact with generators without first removing them, and they should not be removed before the unit has been shut down and grounded. When it becomes necessary for an employee to pass between the engine or vertical units and the flywheels, guards should be installed with sufficient strength that the weight of a falling man cannot break them.

Bare steam lines placed in engine rooms or around the plant have caused many superficial burns, and sometimes these have become infected with serious results. They should be insulated whether placed for permanent use or only for limited period. Often lines have been run to pits for the removal of surplus water by the use of a steam jet, and when unprotected, an employe may grasp the pipe with his bare hand and be injured.

When applying asphaltic or creosote paint to buildings or boiler fronts and stacks, painful injuries can be prevented by applying a generous film of grease paint or vaseline to the face. Creosote paint has a nasty habit of penetrating the pores of the skin, especially when the sweat is pouring off the body. While skin burns from this source may not be classed as accidental, injuries can be prevented by a little head work.

Painful burns can be caused by stepping into a mud hole. These holes have occurred in many plants from leaking collars or from holes in pipe brought about by corrosion. Often waste lines from preheaters or other equipment are laid from junk pipe to drain the condensate from steam to the hot well or the sewer. Bubbling mud geysers should be extinguished as soon as they form, either by placing a collar clamp on the line or by replacing the defective joint. At any rate, the hole should be filled with gravel or crushed stone to prevent an employe accidentally stepping into them. An employe was injured in the Seminole field at one time by backing out of a still room where one of these mud holes had formed. He had called the superintendent's attention to the condition days before, but it had not been repaired. Result? Fifteen days in the hospital with an infected foot; loss of time and pay. A shovel full of broken brick-bats could have saved this employe the pain and loss of time.

Hurry has caused many accidents in construction of gasoline plants and refineries. "Crum" bosses and foremen have developed a habit of rushing men when the superintendent is looking on, and the boll-weevils working for him, being inexperienced at times, have stumbled over equipment laying around, or bucked the tongs at the wrong time and became injured. Backs have been sprained by too much hurry in lifting heavy objects. It is true that speed is essential in erecting most refining and gasoline equipment, but more time could be saved by employing foremen with a brain working, than by trying to speed up a crew of green men without method in their work.

When engines are being repaired, especially when minor adjustments are being made, placards should be placed on the starting valves so the engineer will know not to start it. There have been instances when engines were shut down for some minor repair about tour change time and the engineer leaving failed to tell his relief all about it. Upon inspecting the room, the engine was "given the air" and men have been injured. Adequate hoists should be provided to assist in lifting the heads, exhaust stools and cylinders, to prevent men from accidentally spraining their backs.

When mixing chemicals in treating gasoline, hoists should be provided so the treater can handle the drums of caustic or carboys of acids without too much effort. The vats or tanks set up for the actual mixing should be protected with heavy roofs and guard rails. Men handling liquid chlorine when mixing with caustic for treating should be provided with gas masks. Leaks should be looked for and when found they should be repaired immediately. Chlorine is a poisonous gas and accidental contact with it in concentration may cause pain and loss of time. Caustic, either liquid or dry will burn the skin, but some men term both caustic and acid burns as "acid burns." When this happens, the man in charge of first aid does not know whether to apply soda or vinegar to the wound, so it is a good idea to keep the two, acids and caustics, separate and to have soda at the acid carboys, and vinegar at the caustic drums. Then the men will apply the proper antidote.

Accidents can be prevented in engine rooms where the air compressor is placed beside one of the gas engines. It is either run by belt drive or individual motor. Often the intake line supplying air for the compressor is a short stub taking in engine room gases as well as air. Sometimes this unit is placed beside the recompressor, and leaks are usually more prevalent on the high side of the machines than at any other point. When the "air jammer" is started, a mixture of gas and air is taken in and when compressed to 250 pounds or so, an explosion results. Air lines leading to the suction should always be laid so that an unquestionable supply of pure air can be taken in for compression.

If a plant costing several hundred thousand dollars is worth operating, it is worth maintaining, not only from the standpoint of safety to men, but for the purpose of keeping the investment intact. When it is permitted to operate in a run-down condition, the results are accidents.

Factors . . .

Affecting the Gum Stabilities of

Gasoline

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WHEN gasoline is placed in storage in contact with air, gum formation gradually takes place. At first oxygen is very slowly absorbed with very little noticeable increase in gum. This is always the first stage in gum formation and will continue for a definite period, dependent upon the stability of the gasoline in question. As time passes the rate of absorption of oxygen will suddenly increase and in a relatively short period the hitherto gumless gasoline may contain such an excessive amount of gum as to render it unsalable. The length of time in the first stage is called the induction period and for a given gasoline will vary inversely with the temperature. The higher the temperature the shorter the induction period. This period is measured in the laboratory with an oxygen bomb at 212° F.

The induction period of a gasoline at any definite temperature, such as 212° F., is dependent upon the amount of unsaturated compounds. The greater the amount of these unsaturates, the more unstable the gasoline. Experimentors have found the cyclic diolefines to be the most offensive in this particular. As little as two percent of these were found to lower the induction period of a straight-run gasoline (freed of gums by acid treating and rerunning) to 45 minutes, while 10 to 30 percent of the simple olefines were required to lower the induction period of this same gasoline to 240 minutes.[1] Straight-run gasolines as a rule contain no diolefines and their induction period is very long. An East Texas straight-run gasoline gave an induction period of over 10,000 minutes, Rainbow 6000, and Smackover 1200. (Yonkers bomb). See Table 1.

The process of gum formation is primarily one of oxidation and without access to oxygen there can be no gum. If it were possible to store gasoline in air tight tanks gum formation would be eliminated. While actually, of course, this cannot be done, yet the supply of oxygen and subsequent gum formation can be reduced by such devices as breather roofs, floating roofs, storage under pressure, etc. Also, storage in large tanks will appreciably cut down the rate of gum formation due to the slow rate of diffusion of oxygen through the gasoline from top to bottom. Rogers, Bussie, and Ward[2] of the Standard Oil Company (Indiana) have shown that the rate of oxidation in a 6000-gallon tank is considerably slower than that in 55-gallon drums, and that oxidation in two-gallon tin cans is roughly twice as fast as in steel drums. Winning and Thomas of The Standard Oil Development Company[3] have also shown that gum formation in five-gallon cans occurs much faster than in 55-gallon steel drums.

TABLE 2

Effect of Sunlight on Induction Period

GASOLINE	Induction Period Before	Induction Period After 2 Hr. Exposure
East Texas Cracked Unt'd	300	180
Smackover Cracked Doc. Trtd	120	60
Rainbow Cracked Doc. Trtd	180	85

The effect of sunlight will also catalize gum formation. See Table 2. However, since light seldom penetrates far into a tank its effect will not be great, unless a relatively large area of its roof is uncovered, or in filling station tanks, where gasoline may have been exposed in the bowl and then drained back into the tank.

The presence of water exerts a stabilizing influence, appreciably increasing its resistance to gum formation. See Table 3.

The temperature of storage is another, if not the

TABLE 1

Properties of Untreated Straight Run Gasolines.

GASOLINE	Grav.	I.B.P.	50%	E.P.	Copper Dish Gum	Glass Dish Gum*	Induction Period	Gum After Oxidation	Oct. No.
East Texas	59.0	90	255	405	1.5	Nil	10,620	40	58
Rainbow	59.5	121	274	401	2.5	Nil	6,810	33	45
Smackover	45.5	164	328	418	2.8	Nil	1,320	.....	70

TABLE 3

Effect of Water on Induction Period

GASOLINE	Induction Dry	Induction Period over Water	Induction Period over Dilute Doctor
Smackover	120	210	210
Rainbow	210	255	....

most, inportant factor in the rate of gum formation, the higher the temperature, the greater the rate. The effect of temperature on different gasolines varies. Thus two gasolines having the same induction periods at 212° F. may have entirely different ones at 100° F. For this reason, it has been suggested[4] that the induction period should be run at two temperatures and the results extrapolated to the expected storage temperature. Bridgeman[4] and later Winning and Thomas[3] have shown, for the gasolines with which they worked, that the rate of gum formation roughly triples for every 20° F. rise in temperature. Thus a gasoline which could just safely be kept in storage for a year at 60° F. could correspondingly be kept for only one ninth of this period or 1 1/3 months at 100° F. This fact helps to explain why color trouble usually appears in summer and abates in winter, since in many cases color stability is closely associated with gum formation.

Methods of treating are also an important factor in the gum stability of a gasoline. Acid treating and re-

TABLE 4

Effect of Doctor Treating on Induction Period

GASOLINE	Treat	Induction Period	
		Before	After
E. T. Cracked P. D.	Doctor	410	265
E. T. Cracked Gaso.	Doctor	255	145
E. T. Cracked Gaso.	Strong Caustic	255	130
E. T. Cracked Gaso.	Dilute Caustic	345	135
E. T. Cracked P. D.	Dilute Caustic	325	240
E. T. Cracked P. D.	Doctor	325	120
Rainbow Gasoline	Doctor	135	65

running, by removing the unsaturated compounds, greatly increases the induction period of any gasoline. Doctor treating, on the other hand, nearly always[5] lowers the induction period. See Table 4. This may be attributed to the extraction of natural inhibitors, since many inhibitors exhibit acidic properties, such as the phenolic amines, and would be removed by a caustic or doctor treat. There is also some evidence that the

TABLE 5

Comparison of Reclaimed with Fresh Doctor Induction Period

GASOLINE	Untreated	Fresh Doctor	Reclaimed Doctor	Fresh ppt. Doctor Sludge
1. East Texas Cracked	300	150	....	150
2. East Texas Cracked	205	90	190	120
3. East Texas Cracked	300	135	240	....

Sample No. 2 treated with reclaimed doctor with I.P. of 190, when retreated with fresh doctor fell to 90.

When sample No. 2 treated with fresh doctor with I.P. of 90 was shaken with reclaimed doctor I.P. increased to 135.

heavier mercaptans may act as inhibitors[6], [7], and these, too would be destroyed by the doctor treat. A gasoline treated with reclaimed doctor is very much more stable than when treated with fresh doctor. See Table 5. This may be due to the formation of inhibitors in the doctor during the reclaiming process and afterwards extracted from the doctor by the gasoline. Some credence may be attached to this theory by the fact that fresh sludge from a previous doctor treat will not give results appreciably different from those obtained with fresh doctor, whereas a gasoline which has been treated with fresh doctor will have its induction period considerably increased when retreated with a doctor reclaimed by steaming and air blowing. See Table 5.

An excess amount of sulfur which might be used in the doctor treat slightly increases the induction period. This result was surprising, as sulfur has long been regarded as an accelerator to gum formation. Mizushima and Yamada,[6] two Japanese chemists working with transformer oils, also observed that small amounts of sulfur increased the resistance of their oil to oxidation. However, a very large excess of sulfur such as a saturated solution markedly decreases the induction period. See Table 6.

TABLE 6

Effect of Sulfur on Induction Period

GASOLINE	% Weight Sulfur	Induction Period
East Texas Cracked	None	315
East Texas Cracked	.002	330
East Texas Cracked	.004	330
Smackover Cracked	None	120
Smackover Cracked	.006	140
Smackover Cracked	Sat'd	60

With the recent standardization by the A. S. T. M. of the glass dish method for determining gum, the induction period as determined by the bomb test becomes of increasing importance as a measure for potential gum and for estimating the length of time the gasoline may be safely kept in storage before excessive gum formation develops. Due to the unsatisfactory correlation existing between storage and bomb tests and also to the variation in the rate of gum formation in the same gasoline under apparently the same storage conditions, it is difficult to arrive at the safe induction period of a gasoline. However, it has generally been accepted that under normal conditions existing between refining, sale and actual consumption of a gasoline, that an induction period of 240 minutes (determined under oxygen pressure in metal bombs) is desirable and some companies are writing this condition into their specifications.

Many cracked gasolines, especially those cracked by the vapor phase method, have low induction periods, some running as low as 35 and 40 minutes. There are several methods by which these gasolines may have their induction period extended.

1. Acid treating and rerunning.
2. Treating in vapor phase with zinc chloride, etc.

3. Blending with a long induction period gasoline, such as straight-run gasoline.

4. Hydrogenation.

5. Addition of chemicals or gum inhibitors.

Since the rate of gum formation is dependent on the amount of diolefines and other unsaturated compounds, removal of these by steps one and two would extend the induction period. Hydrogenation, likewise, by conversion of these unsaturated compounds into saturated ones will increase the induction period.

Blending with a more stable gasoline, while increasing the stability, usually does so in but a small proportion of the ratio in which it is blended. See Table 7.

TABLE 7

Effect of High Induction Gasoline With those of Low Induction

Percent High	Percent Low	Induction Period of Blend
SAMPLES—Nos. 1 AND 2		
100	0	795
75	25	320
50	50	195
25	75	190
0	100	180
SAMPLES—No. 3 and 4		
100	0	1000
12.5	87.5	435
25	75	300
50	50	225
0	100	160

Adding chemicals in small amounts as inhibitors is probably the most convenient and economical method of increasing the gum stability of a gasoline.

The inhibitor merely prolongs the induction period after which oxidation proceeds in the same manner as originally. To be effective, a gum inhibitor must itself be oxidized, not by the oxygen of the atmosphere, but by the peroxides which are formed in the gasoline. Therefore, the relative ease with which a chemical is oxidized is an important characteristic of its inhibiting power. A chemical which is too easily oxidized will soon be destroyed by the O_2 of the air, one that is too difficult to be oxidized will not reduce the peroxides which are formed in the gasoline and will, therefore, not possess any inhibiting powers. There is, then, a happy medium between these two extremes in which all classes of inhibitors will fall. Attempts have been made to measure the oxidation potentials of chemicals as a means of determining their ability as inhibitors[8]. These attempts have been only partly successful, possibly due to complications arising in the method of arriving at this potential.

Desirable characteristics of gum inhibitors in addition to inhibiting properties are:

1. A greater solubility in gasoline than in water. An inhibitor which is very much more soluble in water is liable to be extracted under storage conditions.

2. In a gasoline that is not to be colored it should not cause discoloration, either of itself or due to its decomposition products.

3. It should be effective in small amounts, so that addition of it will not affect other properties of the gasoline.

4. It should be sufficiently soluble in gasoline so that large enough amounts may be dissolved to be effective and not be precipitated by changes in temperature of the gasoline.

5. Its cost, of course, would be the final economic factor governing its use.

The following are the more common commercial inhibitors which have been investigated in this laboratory:

Alpha Naphthol.
Mono benzyl-p-amino phenol.
P-hydroxy morpholine.
Di benzyl-p-amino phenol.
Universal Oil Products Inhibitor.
Ox Color Works Inhibitor.
Para Amino Phenol.
Alpha naphthylamine.

These results are tabulated in Table 8. Two doctor treated gasolines, cracked on a Winkler Koch unit from Rainbow and Smackover crudes with induction periods

TABLE 8

Effect of Inhibitors in Gasoline

INHIBITOR	Price $/#	Concentration Gms. Car	Concentration Weight %	Induction Period Minutes	Minutes Increase per 1000 Gm. per Car	Minutes Increase per Dollar per Car	% Effective Relative to Alpha Naphthol
SAMPLE—Rainbow Liquid Phase Cracked Doctor Treated Gasoline.							
None (control sample)	.....	.....	.....	210	.....	.....	.....
Monobenzyl-p-amino phenol	3.00	1000	.....	595	385	58.5	43.0
Alpha naphthol	.65	1000	.0044	405	195	136	100.0
Para hydrozy phenyl morpholine	2.00	1000	.0044	405	195	44.4	32.6
Di-benzyl-p-amino-phenol	1.33	1000	.0044	310	100	33.8	24.8
Universal Oil products	.....	5350	.01% Vol.	310	100	.....	.....
Alpha naphthylamine	.33	1000	.0044	330	120	166	122.0
p-amino phenol (Sat's Sol)	.78	1000	<.0044	330	>120	>70	>51.5
Ox Color Works	.21	3400	.01%	270	60	38.4	28.2
SAMPLE—Smackover Liquid Phase Cracked Doctor Treated Gasoline.							
None (control sample)	.....	None	None	135	.....	.....	.....
Monobenzyl-p-amino phenol	3.00	1000	.0044	360	225	34.1	36.2
Alpha naphthol	.65	1000	.0044	270	135	94.4	100.0
Di-benzyl-p-amino phenol	1.35	1000	.0044	285	150	50.5	53.5
Alpha naphthyl amine	.33	1000	.0044	180	45	62.2	65.8

*Capacity of car=8000 gallons. 1000 gms.=1 kilogram=2.2 pounds.
Symbols: <less than and > greater than.

of 210 and 135 minutes were used as the control samples. The three right hand columns in this table summarize the effectiveness of the inhibitors. While mono benzyl-p-amino phenol was the most effective per unit weight used, yet on a price basis it is only 43 percent as effective as alpha naphthol in the first gasoline and 36.2 percent in the second. On the basis of these results it would seem that alpha naphthol and alpha naphthylamine are the most economical in this group for these two gasolines. However, Rogers, Bussies and Ward[2] in their work show that a gasoline inhibited with alpha naphthol will not be as stable in storage as its induction period tends to show. Even if this held true in this particular case it does not seem probable that these inhibitors would completely lose all their economical advantage.

As will be noticed in Table 8, inhibitors which are effective in one gasoline may not prove to be so effective in another, and the relative values of inhibitors may be reversed in different gasolines. Thus alpha naphthylamine was the most effective in the first sample while alpha naphthol was the most effective in the second.

Attention is called to the way in which the results in the last column, percentage relative effectiveness, were derived. These percentages are the ratios of the minutes increase in the induction period per unit of cost. Since the induction period[9] will be directly proportional to the concentration of the inhibitor present, these relative percentages will hold true at any concentration. It is believed that this method gives a true picture of the inhibiting qualities of any inhibitor for any particular gasoline. Other factors must be considered separately, such as discoloration, solubilities, etc.

The relative effectiveness of the various inhibitors in Table 8 are based on the length of their induction periods only, no attention being paid to the amount of gum formed. This is the most simple and convenient method, as these inhibitors simply delay the oxidation reaction, and do not affect the manner of oxidation or amount of gum formation after the end of the induction period has been reached.

These results are in accord with those of Scheumann of Empire Oil and Refining Company[10], who measured the effect of these inhibitors upon the amount of actual gum formed at the end of a four-hour period, under 100 pounds oxygen pressure and 212° F. He then expressed his results in the form of a gum index showing the percent gum reduction per unit of weight, per unit of volume, and then divided his gum index into the cost price per pound to obtain his economic factor. His data is recalculated in Table 9 and expressed in the same units as used in Table 8. This makes possible a more direct and better understood comparison of his data with that obtained here. As seen from Table 9 his data shows monobenzylparaaminophenol to be the most effective on a weight basis but alphanaphthylamine to be most effective on a price basis.

TABLE 9

Scheumann's Data Recalculated

	Scheumann's Gum* Index	% Potential Gum Reduction Per Dollar Per Car**	Dollars Per Car** to Reduce Potential Gum 100%	Percent Effective Relative to Alpha Naphthol
Alpha Naphthylamine	36	164	.61	113
Alpha naphthol	63	115	.69	100
Monobenzylparaaminophenol	157	78	1.28	54
Dibenzylparaaminophenol	84	63	1.59	44

$$\text{*Gum Index} = \frac{\text{Percent Potential Gum Reduction}}{\text{Milligrams/100 cc}}$$

Where potential gum is gum formed after four hours oxidation under 100 lbs. oxygen pressure at 212°F.

**Capacity of car=8000 gallons.

All the inhibitors in Table 8 have satisfactory gasoline-water solubility ratios and are sufficiently soluble in gasoline to be used in effective concentrations. An exception to this is paraaminophenol, which is not sufficiently soluble in gasoline to be effective in a very low induction period gasoline. Nearly all of these inhibitors more or less accelerate discoloration of the gasoline on exposure to sunlight. See Table 10.

The results tabulated in Table 10 were obtained on

TABLE 10

Effect of Gum Inhibitors on Color

INHIBITOR	COLOR				REMARKS
	Conc. Gms. per Car	Original	After Adding Inhibitor	After 1 Hr. Sun Exposure	
Alpha naphthol	1000	25	25	11	Inhibitor added in Benzol or Benzol-Acetone Solution
Alpha naphthylamine	1000	25	25	Milky	
Monobenzyl-p-aminophenol	1000	25	25	18	
Dibenzyl-p-aminophenol	1000	25	Pink Cast	Pink	" "
Parahydroxyphenylmorpholine	1000	25	25	16	" "
Alpha naphthol	1000	25	25	15	Inhibitor dissolved directly in the gasoline. No solvent used.
Alphanaphthylamine	1000	25	25	Milky	
Monobenzyl-p-aminophenol	1000	25	25	19	
Dibenzyl-p-aminophenol	1000	25	25	11	
Parahydroxyphenylmorpholine	1000	25	25	17	
Alpha naphthol	1000	25	25	15	Gasoline washed with dilute sulfuric acid solution and inhibitor dissolved directly into gasoline. No solvent used.
Alpha naphthylamine	1000	25	25	Milky	
Monobenzyl-p-aminophenol	1000	25	25	20	
Dibenzyl-p-aminophenol	1000	25	25	11	
Parahydroxyphenylmorpholine	1000	25	25	17	
None	None	25	.....	20	Control sample

TABLE 11

List of Chemicals Taken From the Literature Which Have Claims As Gum Inhibitors

Anthracene
Anthraquinone
Alpha Naphthol
Aldol alpha naphthylamine
Beta Naphthol
2 - amino-5-Dihydroxy naphalene
Cresol O-m-p-
Catechol
Di-o-tolylquanidine
Di-tri-ethanolamine
Di butylamine alpha naphtholate
Di phenyl ethlyene diamine
Di benzyl-p-amino phenol
Para hydroxy morpholine
Di phenyl hydrozine
Dianisidine
Ethyl phthalimide
Ethyl-seleno mercaptan
Guanciol
Hydroquinone
Hydroquinone dianilide
Diphenyl-p-phenylene diamine
4-hydroxy-l-3-dimethyl benzene
1-5 Dihydroxynaphthalene
p-Phenylene diamine
p-Nitroso phenol
4-4′ Dihydroxy bi phenyl
p- amino mono methyl aniline
p- amino di methyl aniline
di beta naphthyl amine
di butyl benzidine
acetyl benzidine
Cinnamalphenyl hydrozine
p-p′ di amino hydrozo benzene
o - thiodip benzyl amine
4 - Amino - beta naphthol
2 - 4 Di amino phenol
p - methyl amino phenol
p - phenyl amino phenol
4-4 di phenyl semicarbazide
Lecithin
Mono benzyl-p-amino phenol
Meta toluidine
Naphthalimide
Phrogallol
Phenol
Phloroglucinol
Phenyl-B-Naphthylamine
Phenanthrene
Peri mono oxynaphthalene
Phthalimide
Phenyl phthalimide
Phenyl seleno mercaptan
Para amino phenol
Resorcylindene
Resorcinol
Succinimide
Selenium
Thio diphenyl amine
Thymol
Tri ethanol amine
Tributyl amine
Triamyl amine

three sets of the same doctor-treated gasoline exposed to the sun at the same time. In the first set the inhibitor was dissolved in benzol or a benzol-acetone mixture and one cubic centimeter of this solution added to a hundred cubic centimeters of the gasoline. In the second the inhibitor was weighed on an analytical balance and dissolved directly into the gasoline, no solvent being used. In the third set the gasoline was washed with half its volume of a five percent sulfuric acid solution, to remove any traces of caustic which might have been present, and then filtered. The inhibitor was again added without the use of a solvent. Little difference was noted between the second and third sets where the inhibitor was weighed into the gasoline, but a notable difference was observed in the first set where the inhibitor had been added in solvent form. This emphasizes the precautions which much be taken in studying the effect of inhibitors on color.

From the data of Table 10 it will be noted that monobenzyl-p-aminophenol and parahydroxyphenylmorpholine have the least deleterious effect on the color. However, it is known that the presence of small traces of caustic will cause the former to throw a gasoline off color, therefore, it appears that parahydroxyphenylmorpholine is the safest inhibitor to use from a color stability standpoint.

Table 11 gives a list of many of the compounds, good, bad, and indifferent, which have been recommended at one time or another as gum inhibitors. Some are too expensive to be of practical importance, others are more soluble in water than gasoline, others produce a strong odor and color; some, such as anthracene and tributylamine are really color stabilizers and are not effective in prolonging the induction period. It is possible that the most economical gum inhibitors of some gasolines may be found in this group, rather than from the more commonly known inhibitors.

CONCLUSIONS

1. Exposure to sunlight greatly accelerates gum formation.

2. Doctor treating a freshly distilled gasoline lowers its induction period.

3. Fresh doctor will reduce the induction period to a greater extent than reclaimed doctor. In the latter case the induction period of the untreated sample may not be appreciably different from that of the treated sample.

4. Blending straight-run gasoline with cracked gasoline is not an effective way to raise the induction period.

5. Sulfur in small amounts will not appreciably affect the induction period.

6. The relative efficiencies of gum inhibitors vary for different gasolines.

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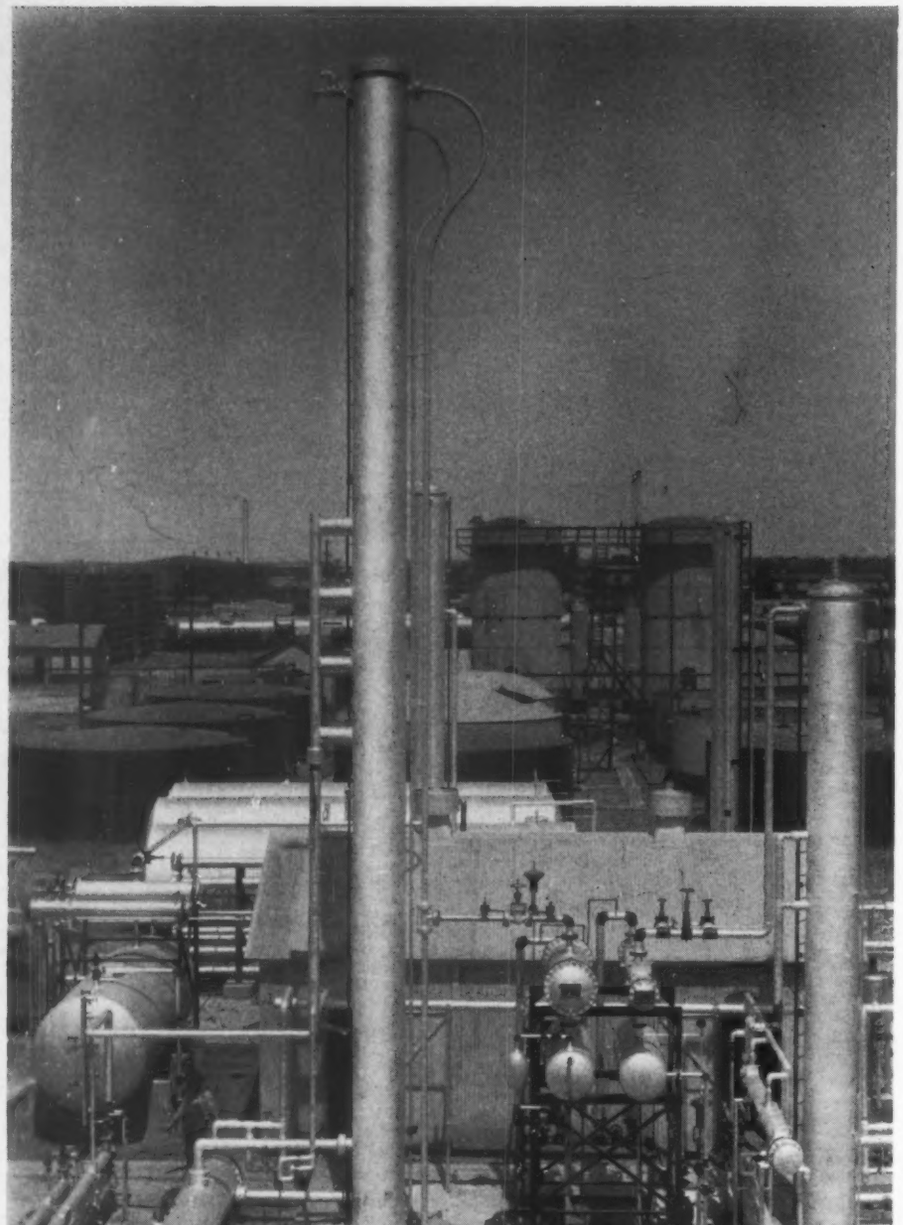


Vapor Recovery and Pressure distillate stabilization plant, Taxman Refining Company, Wichita Falls, Texas.

Gasoline Plant *and* Debutanizer

TAXMAN Refining Company, Wichita Falls, Texas, recently erected a new pressure distillate debutanizer and vapor recovery plant. This company has a combination skimming and cracking plant processing Panhandle, Gray County and North Texas crudes, refining it into several grades of motor fuel, kerosene, the heavier distillates and fuel oil. The recovery and stabilization plants were designed to be operated in conjunction with each other. The plant is arranged, however, so that either may be operated independently. As other plants of this nature, the most economical plan of operating is that both units be placed in equilibrium and run almost as a single unit performing different duties.

The condensation of the pressure distillate and straight-run gasoline, together with the separation of the principal volume of lighter vapors coming from both processes is accomplished in submerged coils and receiving drums at the refining units. These distillates and vapors are reduced in temperature to 90° F. before they are transferred to the new unit for final processing. The pressure distillate is picked up from the re-

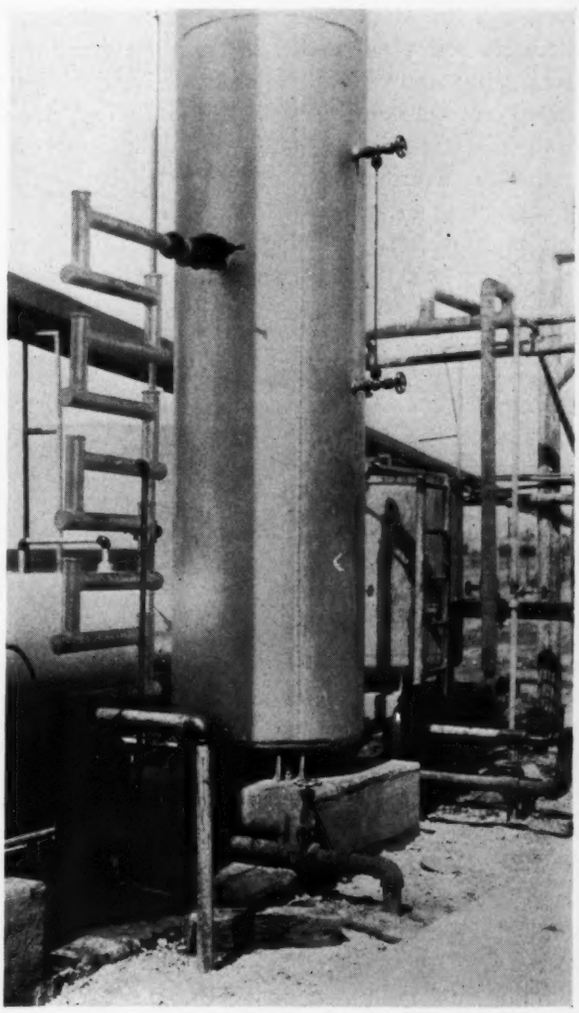
ceiving drums and vapor separators, which are carried at a pressure of 20 pounds gauge, by 4½ x 3¾ x 4 steam-driven duplex reciprocating pump running at an average speed of 26 strokes per minute; controlled by a steam throttle valve actuated through remote control by a liquid level controller placed on the side of the surge tank. This controller permits the distillate to be pumped to the debutanizer in varying amounts as it is condensed in the submerged coils and accumulated in the receiving drums.

The process of refining permits the production of about 1050 gallons of pressure distillate per hour and it is directed by the debutanizer charging pump to a bank of three exchangers and a single preheater. The preheater requires about 300 pounds of steam per hour at 125 pounds boiler pressure while it is being operated at this rate. Heat absorbed through exchange with the butane free pressure distillate and in passing through the preheater is sufficient to obtain a temperature of about 280° F. as the material passes into the debutanizer column. The column, a tower 24 inches by 28 feet, is operated at 56 pounds pressure, with the reboiler, or kettle, carried at 275° F. The equilibrium point, as determined from local operating conditions, for the entry of pressure distillate to the column is through the lower entry port. Steam to maintain operating temperature on the reboiler is admitted to the shell through a control valve, and the amount required averages 450 pounds per hour at 125 pounds boiler pressure.

Pressure distillate as it flows down through the column over the fractionating plates is stripped of the unnecessary light fractions by the heat in the reboiler. To prevent escape of the desirable fractions, the top of the tower is maintained at a temperature of about 200° F. Vapors leaving the tower are held under constant back pressure before entering the reflux condenser so that the debutanizer column can perform its duties with greater precision than if the back pressure controller was placed on the vapor line leading from the reflux condenser accumulator drum. This overhead stream is condensed by passing it through a water-cooled tube and shell unit set directly above the accumulator drum and a portion of it is returned to the top of the column by a 4½ x 2¾ x 6 steam-driven pump to maintain the required top temperature and to wash down the heavier fractions. To maintain the desired top conditions, it is necessary to return approximately 2½ gallons of reflux per minute. The excess amount of reflux condensed is passed on by process pressure to the fractionating still accumulator tank in the recovery plant. The surplus averages about three quarters of a gallon per minute, the composition of which is butane and lighter.

Pressure distillate as it is being finished by the operation of the debutanizer column flows from the reboiler through the initial bank of heat exchanging sections, counter-flow to the incoming charge, and from these three units, it is directed through two shell and tube final coolers which are operated by water flowing through on the opposite side of the tubes. The flow of the finished pressure distillate from the reboiler is controlled by a liquid level controller set on the side of the reboiler shell actuating the outlet valve, which is placed on the line after the pressure distillate leaves the final coolers. By this method, a constant pressure is maintained on the material in process preventing surging of the liquid as it flows through the various auxiliary units of the debutanizer.

The stable pressure distillate after it has been processed through the debutanizer and cooled in the auxiliary units of the plant flows under partial process pressure to the first stage of the final treating unit. Set some distance from this plant and near the run tank battery, the primary treater consists of a set of caustic contacting drums where the chemicals are pumped through contacting columns while the flowing pressure distillate is prepared for final sweetening. This operation is continuous and the material being treated is



Sodium plumbite tank and contacting device for mixing chemical with oil being treated.

drawn from the settling tank to temporary storage from which it is picked up the next day to be contacted with doctor solution before being blended with other materials for shipment as motor fuel.

The major portion of the vapors processed through the gasoline recovery plant is received directly from the gas separators at the pressure distillate receiving drums. The volume is augmented by the addition of gases returned from the debutanizer reflux drum and others coming from the skimming unit condensate accumulators. Vapors coming from the refinery run tanks and from the skimming unit are picked up by a small steam-driven compressor which operates under an intake vacuum of 20 inches and discharges at 25 pounds. The load of gas handled by this machine is discharged directly through a small shell and tube partial condenser and the gas and condensate flows directly to the gasoline plant accumulator tank without being separated.

Three gas transportation lines converge at the single scrubber set near the base of the absorber (a column 24 inches by 32 feet) one of which carries the gas from the cracking unit, another handles gases from the reflux condenser on the pressure distillate reflux condenser, and the other brings in the composite mixture of uncondensed vapors released from the fractionating still accumulator tank. The volume handled by the absorber averages around 800,000 cubic feet per day and this mixture is introduced into the base of the column at an average temperature of 90° F. The pressure carried on the column is maintained at 20 pounds which is considered sufficient for economical extraction. After it is contacted with the absorption oil in the column, the stripped gas is released from the top of the column as residue and directed through a primary scrubber at the base of the tower set on the opposite side from the intake scrubber. The residue passes directly from this drum to a gas holder from which it is removed to be used as fuel in the various processes of the plant and for the generation of steam in the boiler battery. The holder was constructed from an old shell still and the back pressure on the absorbing system is controlled at the outlet of this shell. The holder serves a dual purpose: that of providing an additional settling tank for oil that might be carried over through the primary scrubber, and serves as a flexible reservoir for the plant fuel supply.

The lean oil is pumped to the absorber column from a small surge tank set on concrete cradles located between the absorber and the still, by a 5¼ x 4¾ x 5 duplex steam reciprocating pump, operating against a back pressure of 35 pounds and at the rate of 27 strokes per minute. The oil utilized for stripping the gas when it enters the top of the column has a temperature of 96° F., and emerges from the base with the temperature elevated to 110° F. The flow from the base of the absorber is controlled by a remote control float actuating a steam throttle on the steam line to the power end of the rich oil pump. This pump which handles the enriched absorption oil is another duplex 5¼ x 4¾ x 5, which delivers the fat oil to a bank of three exchangers, counter current to the lean oil entering the absorber, and a single preheater. It enters the fractionating still under an acquired temperature of around 330° F. and a pressure of 35 pounds.

Live steam at the rate of about 400 pounds per hour is required to obtain the operating temperature of the oil entering the still, and about 120 pounds per hour is utilized in the base of this column to obtain partial pressures and agitation of the oil for separation of the lower boiling fractions from the absorption medium. The stripped oil from the base of the fractionating still is released through a float controlled liquid level instrument and flows out under a temperature of 320° F. to the heat exchangers and a bank of two shell and tube final coolers, to the surge tank at the beginning of the cycle.

The top section of the fractionating still is operated at 198° F. by being refluxed at the rate of approximately nine gallons per minute with a portion of the condensed gasoline from the plant production being pumped to a point at the top of the column near the vapor outlet. Vapors fractionated to end point are carried from the top of the column and condensed in a tube and shell unit. The gasoline condensed in this section drops directly into the accumulator drum at an average temperature of 95° F. during hot weather. The accumulator drum is a tank holding about 1000 gallons which serves the purpose of forming a surge tank from which the stabilizer pump takes suction and for the separation of uncondensed vapors coming through with the gasoline made in the still and through compression.

This gasoline is picked up from the accumulator tank surge drum by a 6½ x 4⅛ x 8 pump at the rate of about 4500 gallons per day, depending upon operating conditions throughout the refinery, and directed continuously to the final fractionator. The direction of flow of the gasoline being treated in this phase of the process is through a finished gasoline to charge exchanger, then through two steam heated preheaters. The gasoline enters the fractionator column at a temperature of about 180° F. through the bottom one of four inlet connections. That point was selected after an analysis of operating conditions and found to be the point best suited for efficient fractionation of the product manufactured.

The stabilizer, or final fractionator, is a column 24 inches by 50 feet, operated at 210 pounds pressure with a kettle temperature of 275° F. The bottom product, having a gravity of 85° A.P.I. is removed from the reboiler, or kettle, by process pressure, passing through the finished gasoline-to-charge heat exchangers and a final cooler. The volume permitted to flow from the exchangers and coolers is governed by a float controller placed on the side of the kettle, actuating a release valve on the line through which the gasoline passes after it has been cooled. This method of control also prevents

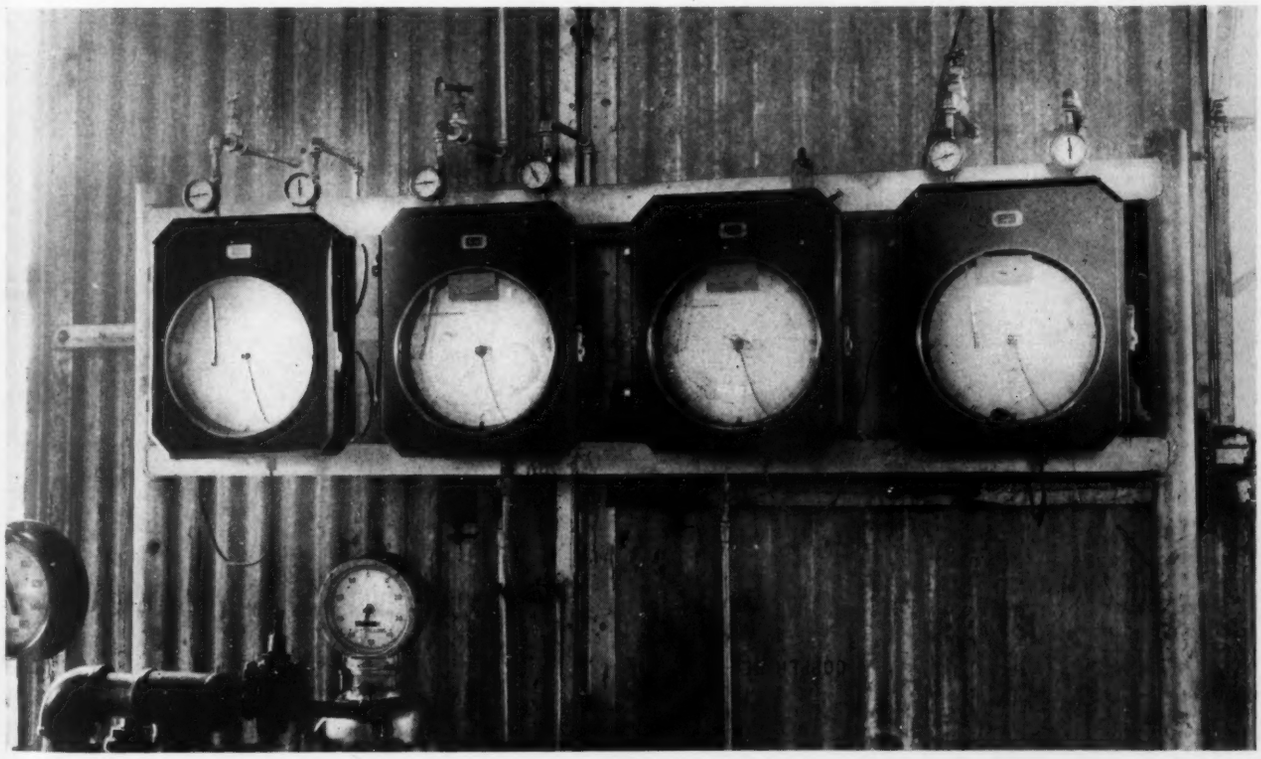
surging of the gasoline and maintains a constant pressure in the exchangers and cooler.

The top temperature of the stabilizer is maintained at or near 156° F. by pumping condensed reflux back over the column with a 6 x 4 x 12 close clearance steam pump running at an average of 12½ strokes per minute. The overhead vapors from this tower are condensed in a shell and tube exchanger by water that has first been passed through the condenser at the fractionating still. The temperature of this water is much higher than that pumped directly from the plant cooling basins, but it has a temperature sufficiently low to accomplish the desired results at the final fractionator.

The amount of the overhead condensate is further controlled by a float set on the side of the reflux drum which actuates a valve on the water line by-pass around the condenser. If the level in the reflux drum falls too rapidly for safe operation, this valve closes the by-pass and permits a larger volume of water to flow through; which condenses more reflux. When the level rises above a predetermined point, the by-pass valve is opened which permits the temperature of the condenser to rise to such a point that condensation is partially arrested. With this arrangement only the required amount of reflux is condensed for column operation, while the excess is vented directly to the plant fuel lines. Without this arrangement, the reflux would condense in greater amounts than the plant requirements and it would necessarily need to be revaporized which would require a steam jacketed expansion valve to provide flexible operation in cold weather.

The stabilized gasoline coming from the reboiler and final liquid cooler, after it has been passed through the fractionating column, is passed directly to a continuously operated doctor sweetening plant under system pressure. It first comes into contact with a caustic prewash to remove the hydrogen sulfide, passing both the caustic from the settling drum and the gasoline through a jet which brings the two into intimate contact.

Sufficient system pressure is maintained from the stabilizer column so that the gasoline flows through the treating plant without pumping. As the gasoline leaves the top of the caustic settling drum, it enters a contactor fashioned from two-inch pipe through which the doctor solution is also pumped for contacting. The sulfur pot is placed on the base where the two vertical settling drums are located, and a split stream, operated by manual control, is taken from the pre-washed gasoline through the pot for addition of sufficient sulfur to complete the reaction. A horizontal drum is placed next to the "doctor" settling tank through which the gasoline passes for final contacting, using a solution pump and zig-zag contactors of the same pattern as those on the "doctor" circuit. This sweetened gasoline is then passed to pressure storage before being blended with straight-run gasoline or finished pressure distillate.



Control board and instruments used in operating vapor recovery and stabilization plant.

THEORETICAL CONSIDERATIONS ON Fractional Distillation and Condensation

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IN the accompanying discussion of physico-chemical laws and their application to design calculations as they concern fractionation equipment, M. Frenc. of Astra Romana questions the use of certain factors and suggests a different method of calculation. Naturally the author's views are his own and as such are presented here.

Further discussion on the subject would be welcome.

ONE of the most important elements used in calculation of apparatus for the seperation of the components of binary mixtures by fractional vaporization and/or condensation in the past was the so-called "gas curve" (termed also equilibrium-curve) of the mixture, see Figure 1.

Hausbrand[1] defines the gas curve as the line obtained when plotting the percentage of the light constituent in the liquid on the abscissa against the percentage of the same constituent in the vapor on the ordinates.

Figure 2 represents another form of the above mentioned curve, from which, in addition to the composition of the vapor and the liquid one can find also the boiling points of different mixtures of the same components. This curve (known as boiling point curve) is used in the same way as the former one for the calculation of fractionating equipment.

The determination of the boiling point curve as well as of the equilibrium curve for the most common mixtures (such as ethyl alcohol and water) has been made experimentally by numerous investigators. Generally such determinations are accompanied by experimental difficulties.

It was soon endeavored to determine these curves based on some theoretical considerations. The first attempt to calculate equilibrium curves were made by Sorel[2], F. D. Brown[3] and Dolejalek[4]. The calculated curves almost never agreed with those experimentally found.

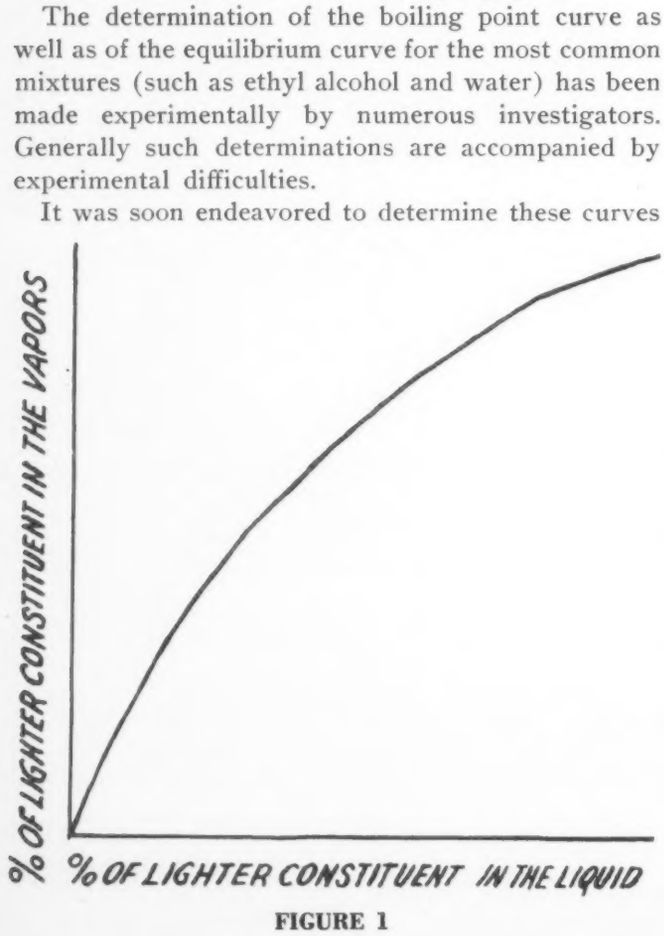

FIGURE 1

Since the development in the application of pipe stills and bubble towers for the fractionation of petroleum and gasoline, new ways and methods for the calculation of the equipment have been investigated. The method based on the equilibrum curve could be used only rarely because for this purpose the determinations of all the curves for the innumerable working conditions (such as variable pressures, different specifications of the feed and of the products etc.) would be necessary. These determinations involve such a tremendous amount of research work that it would be an almost hopeless undertaking. The difficulty of the situation is increased by the fact that a great number of hydrocarbons have never been isolated in a pure state. The investigations were directed toward finding a method of basing the calculations on the compositions of the respective mixture (supposing it is known) and the vapor pressures of the constituents. The American investigators, and the American Petroleum Industry have given the largest contribution to elaborating the new methods.

The well known physico-chemical laws served as the base, namely:

(1.) The law of Raoult.
(2.) The law of Dalton.
(3.) The equilibrium rule.

All the attempts to solve the problems arising from the fractionation of complex mixtures were initially based on these laws. Under fractionation there is

to be understood not only the partial vaporization (flash vaporization) but also the partial condensation (dephlegmation) and also rectification with columns, which is strictly speaking, a series of successive adiabatic evaporations and condensations.

All the fractionation problems can be reduced to a basic one, namely: "What will be the composition and the amount of vapor and liquid resulting from a given liquid or gaseous mixture at a given pressure P and a temperature T after the equilibrium is reached." Based on the above laws this problem can be solved as follows:

Let us assume a mixture of N constituents in proportion of (molecular)

$$\Delta X_1 : \Delta X_2 : \ldots\ldots\ldots\ldots : \Delta X_n$$

If there is M moles of this mixture, then we have

$$\Delta X_1 + \Delta X_2 + \ldots\ldots\ldots + \Delta X_n = \mu = \sum_{n=1}^{n=n} \Delta X_n$$

At T° and P Atm. abs. we will have L Moles of liquid consisting of the same constituents but in the proportion:

$$\Delta y_1 : \Delta y_2 : \ldots\ldots\ldots\ldots : \Delta y_n$$

and D Moles of vapors of the composition

$$\Delta Z_1 : \Delta Z_2 : \ldots\ldots\ldots\ldots : \Delta Z_n$$

in this case

$$L + D = \mu \qquad (1)$$

$$\Delta y_n + \Delta Z_n = \Delta X_n \qquad (2)$$

If the vapor pressure of Nth constituent at T° is P_n than the partial pressure p_n of this constituent in the liquid (following Raoult) will be:

$$p_n = \frac{\Delta y_n \cdot P_n}{L}$$

and the partial pressure p^n of the same constituent in the vapors will be

$$p^n = \frac{\Delta Z_n \cdot P}{D}$$

In equilibrium state the two partial pressures are equal, thus

$$\frac{\Delta y_n . P_n}{L} = \frac{\Delta Z_n . P}{D} \qquad (3)$$

Substituting D and ΔZ_n by their values from (1) and (2) we have

$$\Delta X_n = \frac{\Delta y_n}{\frac{\mu - L}{L} \cdot \frac{P_n}{P}} \qquad (4)$$

The expression is correct for all constituent. Thus summarizing we have:

$$L = \int_0^e d X = \int_0^e \frac{d Y}{\frac{\mu - L}{L} \cdot \frac{P_n}{P}}$$

This formula gives the composition of the liquid. The same method is to be followed for the composition of the vapor.

This general method of calculation is of somewhat troublesome application and the petroleum industry preferred to substitute methods of calculation of particular cases for it. For mixtures with high boiling points, whose exact composition is almost impossible to determine, use was made of the "true boiling point curve" whereas for the whole domain of manufacturing and stabilization of gasoline, a simple method of calculation was given by Murray[7].

It was soon observed that the theoretically calculated data did not agree exactly with the laboratory results. As the deviations between experimental and theoretical results (based on Raoults law) could be represented graphically by a regularly shaped curve the cause could not be ascribed to faulty determinations of vapor pressures, or molecular weights of the components.

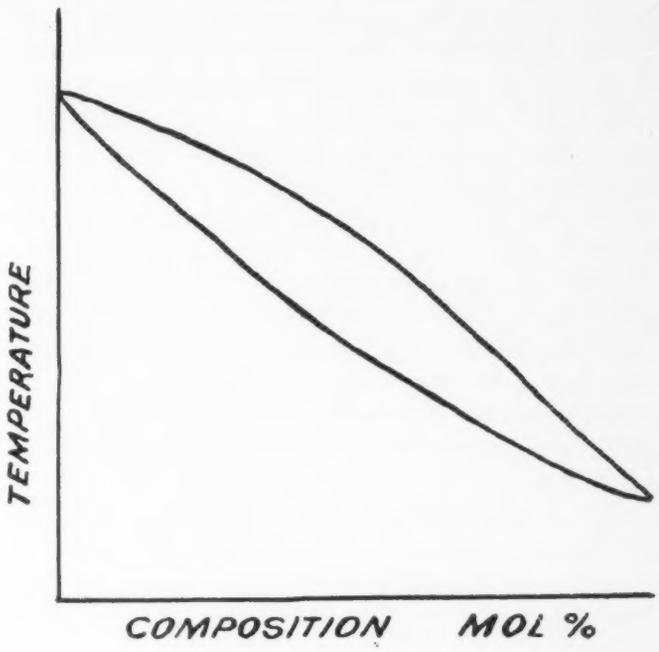

FIGURE 2

Considering these deviations one is rather led to suppose that Raoults law does not hold exactly[5 6] and attempts were made to overcome this. Different formulae were brought out for each case. For the flash vaporization it was proposed to take into consideration the carrying effect of light ends and to correct the deviations by a formula deduced from the Clausius-Chapeyron equations[5]—Murry[7] introduced in his method of calculation a correction factor based on van der Waal's equation of state for highly compressed gases, etc., while in the calculations of bubble towers besides the plate-efficiency factor equal for all trays, another factor was introduced with a varying value for each tray[6].

In this manner the application of Raoults law led to new difficulties and complications in the calculation of the fractionating elements. The application of Raoult's law to fractionation is in any case doubtfull because:

1. This law holds true only for solutions of low concentrations.
2. It does not take into account the change of the

molecular state of the same constituent in different solvents.

3. The vapor pressure of mixtures calculated from this law does not coincide with the vapor pressures of the same mixtures, as determined by experiment.

The above difficulties can be done away with only in case Raoults law is rejected, and the whole fractionation considered from a different point of view.

Among the first, G. N. Lewis[9] tried to create another base for fractional distillation calculation by introducing the idea of "fugacity." The "fugacity" of a gas or a liquid would be an "ideal" vapor pressure, i. e., an empirically determined vapor pressure corrected by some theoretical considerations. To operate the "fugacity" Lewis and Randall established a rule, similar to Raoults law in respect of the vapor pressure. Later investigations have taught that the new method enabled only rough approximation and this only for a limited set of temperature and pressure conditions.[10]

In the opinion of the writer, to build up a new base for such calculations the following must be considered: every fractionation must be considered as a closed system containing a vapor and a liquid phase in equilibrum. If it is considered on the other hand that a mixture of a gas and a liquid (i. e., air and water) in a closed space possesses the same character as the foregoing system, it can easily be deduced that there is no basic difference in the physico-chemical behavior of both systems. This assumption is also confirmed by the fact that the fractionating temperatures are normally higher than the boiling point of lower boiling constituent in a pure state, all other conditions being the same.

Based on the above considerations, all the calculations concerning fractionation can be made using instead of Raoults law the following laws.

1. All the solubility laws of gas in liquids; among them the laws of Henry and the distribution rule of Nernst; 2. Dalton's law, and 3. The equilibrium rule and the curves of the solubility coefficient is temperature of lighter constituents in the heavier.

The determination of these curves cannot be the cause of insurmountable difficulties from the standpoint of apparatus, especially when the constituents are of similar chemical structure.

Unfortunately almost no data exists on the solubility of the vapors of law boiling components in higher boiling liquids. Nevertheless in many cases some qualitative regularities can be easily observed, permitting important general conclusions to be drawn about the fractionation of known mixtures; many phenomena accompanying fractionation, which cannot be explained with the aid of Raoult's law become evident through such an assumption.

In the first place it must be pointed out that by the application of solubility laws a parallel can be drawn between the phenomena accompanying fractional distillation and fractional crystallization; bearing in mind, for example, the similarity of the entectic mixtures that have the lowest congealing point of all possible mixtures of the constituents and an azeotropic mixture that possesses in the same way the lowest boiling point. Going further with the comparison between distillation and crystallization, it can easily be assumed that in the same manner as a mixture of two solids (not reacting one with the other) can be separated through their unequal solubility in a given liquid, it must also be possible to separate to a certain degree by fractional distillation two liquids with the same boiling point by mixing them with a third higher boiling liquid, in which the vapors of both foregong liquids are unequally soluble. Raoult's law is absolutely insufficient to explain this last phenomenon; in the same way Raoult's law does not account for the fact that a mixture of two liquids with a given difference between their boiling points can be fractionated easier than a mixture with the same or even greater boiling point difference of the constituents, all other conditions being equal.

The calculation of the apparatus and of the working conditions for fractionation of a binary mixture based on these considerations, can be made if the relation between the solubility and the temperature are first known.

The general way of solving the problems of how much liquid and how much vapor and of what composition, will be formed from a given binary mixture is the following:

Assume a mixture containing A moles of low boiling and B moles of the higher boiling constituent. The composition of the vapor and the liquid at the temperature T and pressure P after the equilibrium is reached must be determined.

Designate with X_1 and X_2 the number of moles of low boiling constituent in the vapor and in the liquid; with Y_1 and Y_2 the same numbers for the higher boiling; then we have:

$$X_1 + X_2 = A \qquad (1)$$

$$Y_1 + Y_2 = B \qquad (2)$$

Further, designate the solubility of coefficient of low boiling in the higher boiling (at T°C and P Atm) with K; then:

$$\frac{X_2}{Y_2} = K \qquad (3)$$

If the vapor pressure of the higher boiling constituent at T°C is P, the partial pressure of this constituent in the vapor will be also P as would also be the case in distillation with steam (see Gurwitsch). The partial pressure of the lower boiling (Dalton) will be $P\text{-}p$ and thus:

$$\frac{X_1}{Y_1} = \frac{P\text{-}p}{P} \qquad (4)$$

We have established four equations of the first degree with four unknowns, giving thus an answer to the above problem. This typical example can serve as a starting point for the calculation of some more complicated mixture.

For the calculation of bubble towers a modification of the method elaborated by Thiele and McCabe[11] can be applied using the solubility—instead of the boiling curve.

How far the data obtained by application of these considerations agree with those practically determined can be seen only in the future when sufficient experimental data are afforded; general considerations show however that such assumptions give the possibility not only to check facts known almost exclusively from experience[12] but to draw further conclusions permitting a look into the future possibilities of fractionation. Two examples are given:

Consider the upper tray of a bubble tower that works at a definite constant temperature; according to the distribution rule of Nernst[8] the whole material above this tray will separate into liquid and vapor in such a manner that the relation of the concentrations of the lighter constituent both in liquid and vapor will also be constant. In this case the higher the content in lighter constituent of the liquid that remains on the tray, the richer will be the vapors; but the composition of this liquid depends upon the composition of the vapors that rise from the next tray beneath; this last composition, all other conditions being equal, is a function of the temperature of this second tray; as the known solubility of gases (in this case the vapor of the lighter constituent) decreases at higher temperatures. Therefore at a constant temperature of the first tray, the fractionation will be the better the higher the temperature of the second tray underneath. In other words, the higher the temperature difference between two trays the better will be the fractionation.

The foregoing will be correct for, and can be applied not only to the relation between the trays 1 and 2 but also to trays 2 and 3, 3 and 4 and so on.

Therefore "the greater the temperature difference between the two trays of a bubble tower, i.e., the faster the temperature drop from the bottom to the top of a bubble tower the better will be the fractionation all other factors being equal." (Moreover earlier observers already arrived at the some conclusion in an experimental way.)[13]

This general principle will tend to substitute in the future the rule of the great reflux ratio which is only a particular case of the first. A great temperature difference at a constant top temperature in a bubble tower involves more heat supply at the bottom. This can be realized in following ways:

1. By direct (fire) or indirect (steam) heating of the bottom (reboiler principle).
2. By superheating the vapors of the mixtures before entering the bubble tower.
3. By using a heat supporting medium introduced separately in the bubble tower; this medium must act neither chemically nor physically on the constituents of the mixture; in the petroleum industry superheated steam and occasionally very low boiling hydrocarbon (methane, ethane, lean gases) are used.
4. By permitting the mixtures to boil at higher pressures and correspondingly higher temperatures and releasing the pressure of the vapor immediately before entering the bubble towers.

There is also a fifth possibility: namely, to vaporize the mixtures at higher temperature without higher pressure. The vapors thus obtained introduce more heat in the bubble towers thus improving the fractionating, but take with them more from the heavier constituent that increases the reflux ratio overloading the bubble tower.

Thus the principle of a greater reflux ratio for better fractionation holds true but represents only a particular case and not the most advantageous of a general principle.

Without insisting upon the relative value and limitations of all the above possibilities, it must be said that each of them requires a corresponding technical layout. Therefore for each mixture to be fractionated, the manner to be applied must be chosen at the right time. It is still to be considered that if one of the first three possibilities is preferred, the heat introduced in the bubble tower must not exceed a certain maximum, sufficient to hold the temperature of the bottom tray below the boiling temperature of heavier constituent thus preventing the vaporization of entire liquid, which would interfere with the efficiency of the bubble towers.

From the above, it can also be deduced that to improve the fractionation of mixtures that can be exposed to higher temperature without decomposition it is to be recommended on one hand to install a vapor superheater between still and bubble tower and on the other, to keep the still under higher pressure and to release the pressure not between the still and the evaporator as it is usually the custom, but between the evaporator and the bubble tower.

The second example will be taken from the laboratory practice. It is a well known fact that different mixtures with the same vapor pressure when determined at a certain temperature have different vapor pressure at higher temperatures (provided the final pressure in the apparatus throughout all determinations remains the same as is the case for example, with the method of Carney). As explained above, this fact speaks against the law of Raoult but can be easily ex-

plained by an assumption as follows: Considering the vapor pressure as the tendency to form vapors, it is obvious that two liquids with different vapor pressure can dissolve such amounts of a third lighter liquid as to form equal quantities of vapor at a given temperature: at this temperature the vapor pressure of both mixtures will be the same. By increasing the temperature, the quantity of vapors formed by both mixtures will also increase, each in function of the respective solubility coefficient. If the curves of variations of the solubility coefficients of such solutions in relation to the temperature are not of the same shape, the vapor pressure of both mixtures at higher temperature will also differ.

As an important conclusion then the following must be pointed out. Insofar as we apply the laws of gas solubility to the fractionation of liquids, it is inversely logical to use the experience up to now with fractional distillation for the benefit of systems considered only as solution of gases in liquids (for example the removal of the last traces of SO_2 from oils in the Edeleanu process, the degasification of feedwater from steam boilers, the selective absorption of constituents from gas mixtures etc.). In this way it can be sometimes economically more advantageous to carry out the absorption or the removal of gas with the aid of a bubble tower.

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Automatic Machinery for Canning Oil

BARNSDALL Oil Company's Barnsdall, Oklahoma, refinery is using modern automatic canning and filling machinery in packaging its motor oils for distribution in sealed containers. The system is designed to handle one-quart cans at the rate of 50 per minute. The five-quart containers are handled by the same machinery.

The new canning plant was installed in one end of the compounding room where the barrels and other large packages were filled before the addition of this equipment. The storage tanks from which the oil is taken are placed overhead so that when they are filled by pumping the desired grades of oil to them, they may be emptied by gravity flow, either into the barrels for bulk shipment to industrial plants, or to the filling and sealing machinery.

All lines leading to these elevated storage tanks terminate in a manifold through the operation of which any S. A. E. grade of oil may be directed to the containers. Leading from this manifold is one two-inch line in which a strainer is placed to prevent any foreign matter from passing to the containers. Just before reaching the filling machine, the line branches to form two 1½-inch lines, with gate valves inserted to shut them off. From these gates, the lines continue by means of flexible oil proof hose which are attached to the double filler mechanism of the can filling apparatus.

Quart and five-quart cans are received in corrugated cases in car lots and stored in a room near the barrel house and are brought from this building to the canning room on an endless conveyor, elevated so they may reach the second story without extra handling. When filling the cans, these cartons are emptied of their contents, and the cans placed near the filling machine convenient to the reach of the operator, while the empty cartons are moved to the other end of the room to receive the cans again as they are filled, sealed and stencilled with the identifying S. A. E. number.

The filler mechanism is electric driven, having a one half horsepower motor driving through a reduction gear from which a chain drive actuates the endless conveyor that removes the filled cans from the automatic filler spouts. An automatic control table lies just beneath the filling spouts adjustable by a system of weight arms so that when a can is being filled, only the amount required is placed in it. The operator places cans alternately under the two spouts, tripping the gate that permits the oil to flow. As one can is filled, electric contact is made beneath the table and the supply is automatically cut off. This severing of the running stream of oil is so abrupt and positive, that to prevent line-hammer an air cushion is placed in the line just back of the spout. This cushion also serves to accelerate the flow of oil to the next container since a slight pressure is held on the stream through a check valve in the line between the air cushion and the supply tanks.

(*Continued on page* 402)

Production of Lubricants *from* Osage Crude

BARNSDALL Oil Company, with refineries in the Mid-Continent area, manufactures a wide variety of petroleum products but concentrate on lubricating oil as the principal product manufactured in the plant at Barnsdall, Oklahoma. Selected Osage crude is charged to this plant, a paraffin base oil, rich in lubricating oil fractions. The refinery at Barnsdall is a complete plant, manufacturing gasoline, kerosene, gas oil, technical naphthas, lubricating oils and waxes. The crude runs on an average of 34.1 degrees A. P. I. and is pumped from the Osage Nation in northern Oklahoma to the storage tanks in the plant by pipe line. It is charged to a two-pass pipe still unit, through the first step by a duplex reciprocating steam pump, discharging under a pressure of 80 pounds. Several heat exchangers are placed in the line of flow to make use of all heat possible before the crude charge enters the first section in the furnace. The exchangers are crude charge-to-residuum and gas-oil, heating the charge and assisting in the cooling of the residuum before it is run to storage.

After passing through the first section of the pipe still the crude enters a horizontal surge tank located between the pipe still furnace and the fractionating columns from which it is picked up by a multistage centrifugal pump driven by a steam turbine, with a discharge pressure of 140 pounds so that the hot oil can be returned to the furnace and heated in the second pass to an outlet temperature of 635°F. The oil in process is led through an insulated line directly to the vapor tower without exchange of heat and two cuts are made. The rough cut removed as an overhead stream consists of gas-oil and lower boiling fractions; naphthas, gasoline and kerosene, while the bottoms are trapped out to an auxiliary stripping column from which two cuts are removed. The overhead stream in this instance is a heavy wax distillate while the bottom product constitutes the long residuum from which lubricating oils are made.

The rough cut from the vapor tower is immediately introduced to the side of the bubble column from which three cuts are removed. The product removed as an overhead stream consists of the gasoline fractions in the original crude and averages about 53.5° A. P. I. The product removed as a side stream is fractionated to kerosene having a gravity of about 41.5° A. P. I., while the bottoms are the gas oil fraction coming from the coolers with a gravity of 34.3° A. P. I. The principal product from this distillation unit is the long residuum from which all of the lubricating oils are manufactured.

In the agitators the long residuum is contacted with 35 pounds of sulfuric acid per barrel of oil. This quantity of acid has been found to be the desirable amount to adequately treat the stock as an average.

When the desired results have been obtained by treating the bottoms are drawn away as acid sludge. The sludge is handled as a valuable by-product, being transferred to a blending plant near the agitators where it is processed so that it may be consumed as fuel for the steam generating plant. The acid contacted stock is given a further treatment with ammonia to neutralize the acidity acquired during the first contact in the agitator.

After the stock in process has been neutralized, it is pumped from the agitator to storage tanks where it is diluted by mixing with enough naphtha to secure about a 50-50 blend. It is then transferred to the west side of the plant where the filter house is located and introduced to a battery of 10 percolation type clay filters for primary decolorizing. These are operated at a temperature of about 100°F. The filters are controlled by testing the stream of oil coming from them at regular intervals, and when the individual filter steam begins to run too dark, it is taken out of service and steamed until all oil has been removed. The clay is also removed from the filter, transferred on endless belts to storage, or sent directly to the multiple hearth furnace for reactivating by burning. No fresh clay directly from the mines is used in these filters; all clay is burned before using. The amount of oil that can be filtered per ton of clay varies considerably, depending upon whether the clay is fresh or has been used a number of times. Only fresh clay, newly burned, is used in the Gray towers at the cracking plant, and after it has served its purpose at that point, it is brought to the multiple hearth furnace and reconditioned for lubricating oil treatment. When a quantity of clay has finally lost its efficiency through glazing by repeated burning, it is removed from the process and dumped to waste.

The diluted stock after passing through the primary decolorizing filter beds is received continuously in two

horizontal surge tanks from which it is pumped to storage. It is then mixed with an additional quantity of naphtha so that it can be easily handled by the centrifuges. The quantity varies as to the original weight long residuum, and the amount used is determined from tests made upon each tank before it is passed to another point in the process.

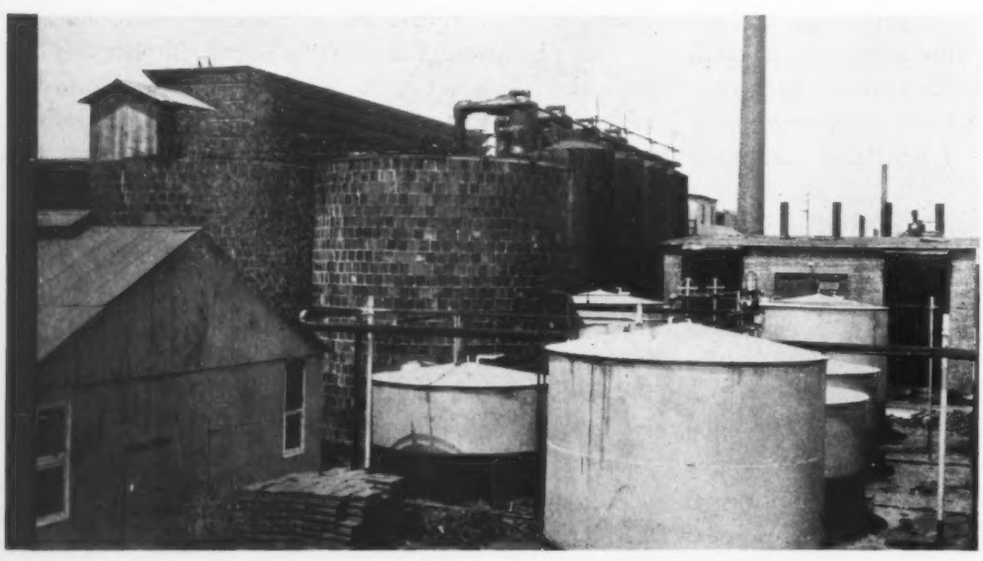
From the blending tanks, the stock is pumped to the batch chillers which are cooled by brine from the refrigerating system. Three tanks were placed in this battery, constructed from steel and insulated with hair felt. The insulation originally was bound to the surface of the tanks with steel hoops, but exposure to atmospheric conditions coupled with dew forming on the steel under the felt caused the insulation to blister. This condition was corrected by sheathing the three tanks with circular tile laid tightly against the outer surface of the felt and since this was done no separation of insulation from the steel surface can come about. The oil is permitted to remain in these batch chillers until a temperature of approximately 0°F. is obtained, when it is removed by pumping to the secondary chilling unit. By using three batch chillers, one of them may be filled while another which has been brought down to the proper temperature is being pumped out and the third is in process of chilling. By using this number in the manner outlined, sufficient stocks properly chilled are always available for continuous pumping to and through the secondary unit.

The stock at 0°F. is continuously being transferred from one of the three batch chillers to the continuous plant. This system has four tanks in the process where the material travels from one to the other, being further reduced in temperature as it is being handled. The temperature to which the oil is lowered in the first chiller, all of which are refrigerated by direct ammonia expansion, averages about —15°F., the second to about —25°F., the third, —35°F. and the fourth to between —45°F. and —48°F. From these secondary chilling units, passing consecutively through each in turn, the refrigerated blend of filtered lube stocks and naphtha is pumped directly through insulated lines to an overhead gravity supply tank which serves the battery of centrifuges placed in a room above the refrigerating equipment.

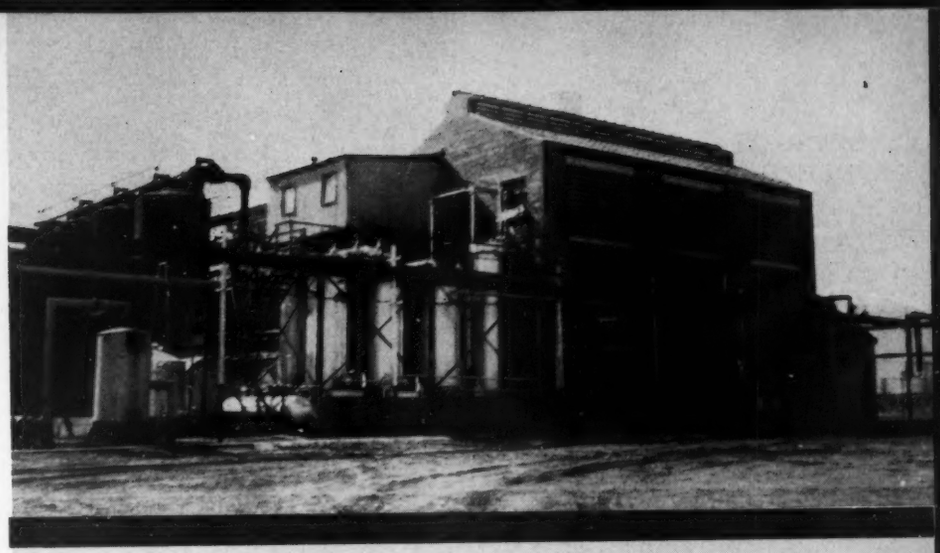
The centrifuges are all operated by individual motor drive, and the wax separated from the stock flows to storage with the assistance of hot water injected into the spout just outside the bowl case. Approximately 16 percent of the original stock is removed in the form of wax, while the dewaxed material, containing all the naphthas placed in the composite whole in the beginning, flows by gravity to storage before being further processed for the removal of the light ends.

The dewaxed oil is pumped from the centrifuge rereiving tanks to a battery of shell stills where the removal of the blending naphtha and other light ends not desired in the manufacture of lubricating oil is accomplished. This process is continuous in that the stocks are processed through these stills consecutively. After this process has been completed, the reduced material removed from the last shell is immediately pumped to another battery of shell stills for batch distillation. Using steam in these stills, distillation is performed at comparatively low temperatures and several grades of overhead products are removed. The characteristics and volume of the overhead streams depend upon market requirements. If, for instance, the market demands a large volume of 100 viscosity, at 210°F., the entire process is controlled from the initial separation in the strip column at the pipe still so that a larger amount of this material is produced. If a small volume of lighter products is not desired, the entire process is reversed so that these ends are removed in the initial process rather than further down the line. This is done so that volume treated in the beginning and throughout the process can be reduced so that costs may be decreased to that extent.

When the oil has been passed through the several stages and the various cuts have been produced, the

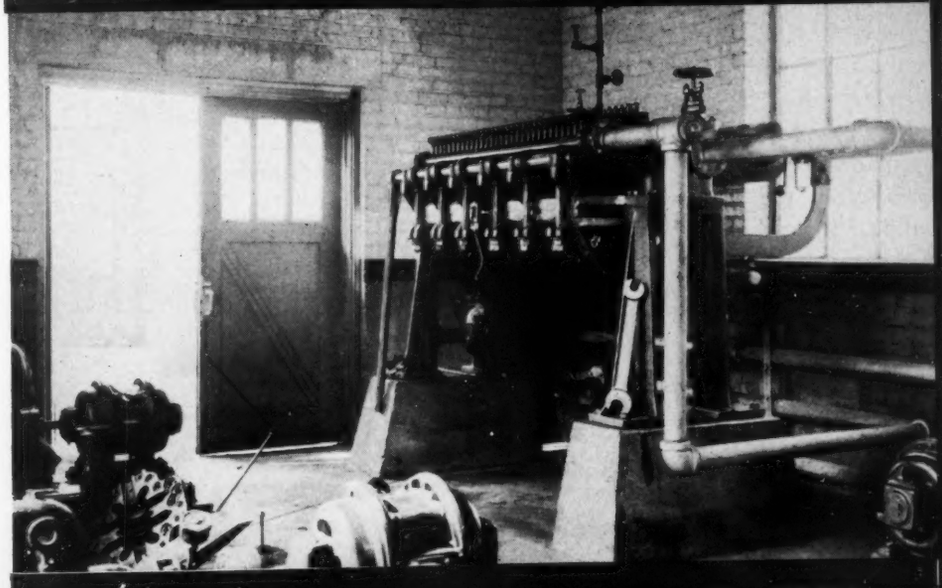


Refrigeration unit showing relation of brine chillers to continuous direct expansion chillers

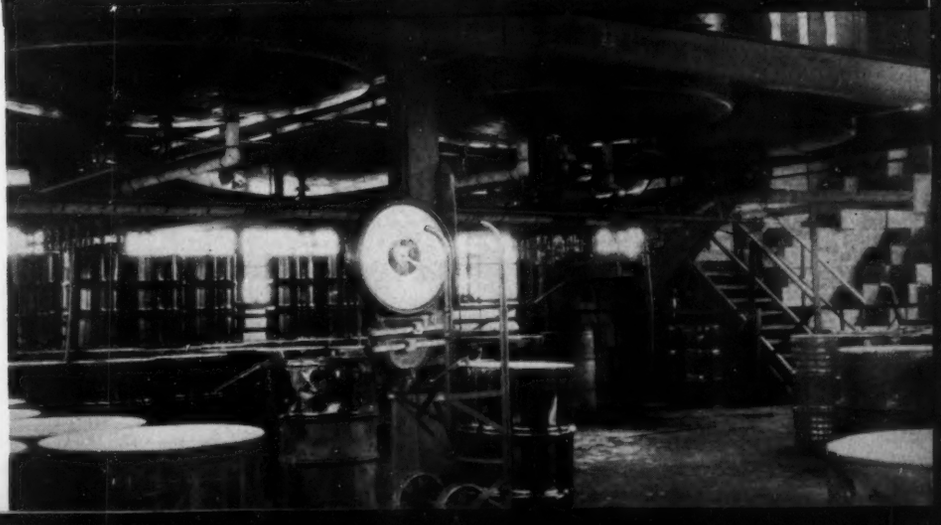


Refrigeration machinery building in Barnsdall's refinery at Barnsdall, Oklahoma

Batch brine chillers where lube stocks are reduced to zero temperature in one step of lube manufacture



Filter press where the finished bright stock is treated to remove any clay which might pass from percolation filters with the stream



Barrel house where the finished lube stocks are compounded to make various grades of lubricating oil

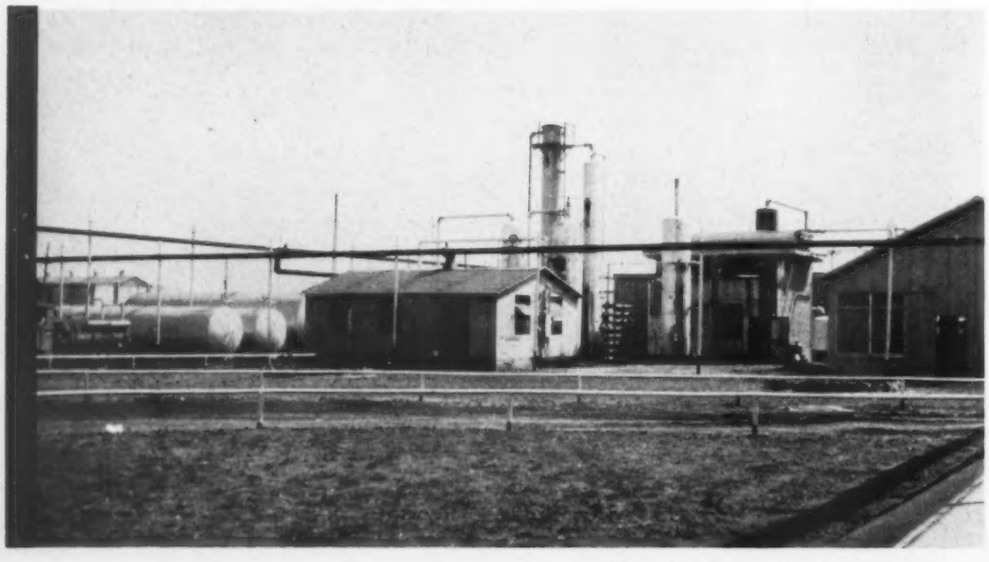
bright stock is pumped back to the filter house to be processed, unblended, through another battery of percolation filters where the desired color is obtained. The stock is received from the base of the filters in open vats from which a continuous stream is passed through a press to remove all traces of foreign matter likely to be carried through with the oil. The finished bright stock is led through pipe lines to the proper storage tanks from which it is pumped to the compounding department for finished product blending, or shipped as bright stock.

When compounding the lighter neutrals with the bright stock to secure the proper S. A. E. grade of finished motor oils, the grade and weight of the overhead neutrals are controlled by distillation. Instead of using the very light tops of the neutrals with the heavier bright stock to secure the desired weight, the neutrals are distilled in such manner that a continuous gradient of viscosities to select from is made available, beginning at the bright stock base and continuing through the range to the lightest cut available. The reason advanced for this method is that the front end and the back end of any blended weight are tied to each other with a middle weight blending oil. This method eliminates a wide gap between the products as when an oil is manufactured from a very light neutral and a quite heavy bright stock, a stabilized oil is obtained that does not have a comparatively high volatility in the front end, and a heavy residual back end.

This method can be illustrated where three distinct cuts are shown to be available; one with a 190/200 viscosity at 210°F., another with a 160/170 viscosity, and the third with a 100/110 viscosity, also at 210°F. When a finished product approximating a 20 S. A. E. grade is desired, it could be prepared by using the proper proportions of the 190/200 and the 100/110, but the gap between the two would be too wide for proper bonding. Instead of this method, the two lighter cuts are separated into several minor divisions, each having a viscosity closely related to the ones above and below. By having these minor divisions available, the compounding rooms can select several of the cuts so that the finished product runs smoothly from the heavier to the lightest without a break in the ultimate composition. This method of compounding is carried out in the manufacture of all grades of motor oils from 10 to 70 S. A. E. and heavier if desired; always taking into consideration that each grade must be closely bonded as indicated by a smooth curve. Not only is a satisfactory bonding effect secured by blending with a larger number of base stocks, but the ultimate viscosity does not fluctuate greatly when subjected to extremes of heat and cold; the change, when it does occur, is slow.

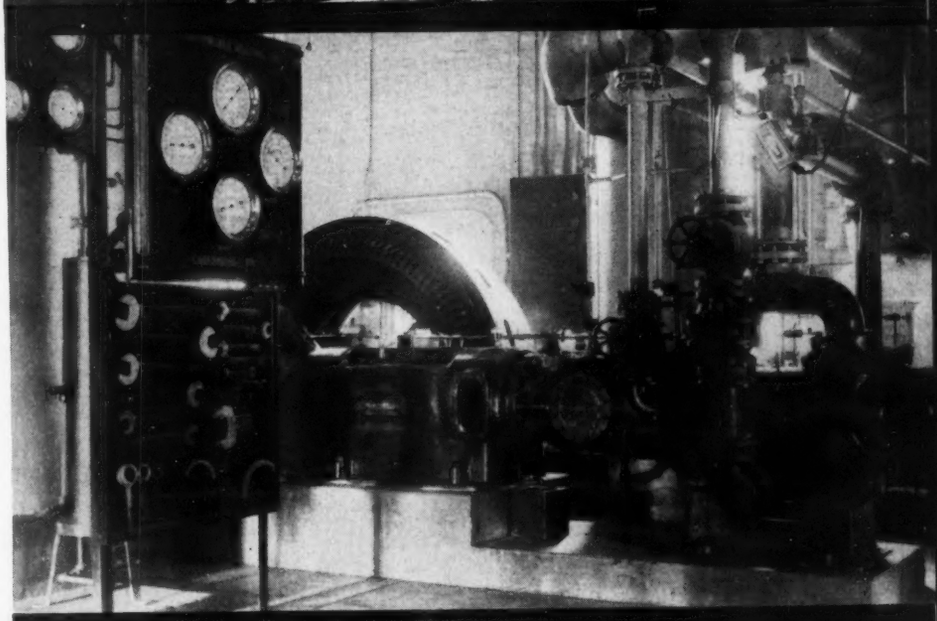
It is said that by following this method of lubricating oil manufacture, treating by the method outlined and by giving the bright stock the final percolation filtering, not only is color stability secured that enables the oils, blended or unblended, to be shipped long distances by tanker under adverse conditions and to arrive at the destination in the same condition as when first manufactured, but the finished product is obtained with no sludge forming propensities. Continual tests are being conducted with automobiles and radial airplane engines to discover if harmful carbon will be deposited on valves, cylinder heads and under the rings of the pistons. Carbon residue tests conducted in the experimental and research laboratories coincide with the road and engine tests; both show that the little carbon evolved is light and fluffy which is easily removed from the laboratory equipment and blows through the valves in the engines.

The investigations carried out in the laboratory and road tests indicate that the oils resist emulsification; which is another reason advanced for employing a method of lubricating oil manufacture that is more expensive than others. The wax is completely removed by centrifuging at the low temperatures to which the oils are subjected. This is indicated from tests made on them at a temperature as low as —90°F., at which temperature no clouding is apparent.

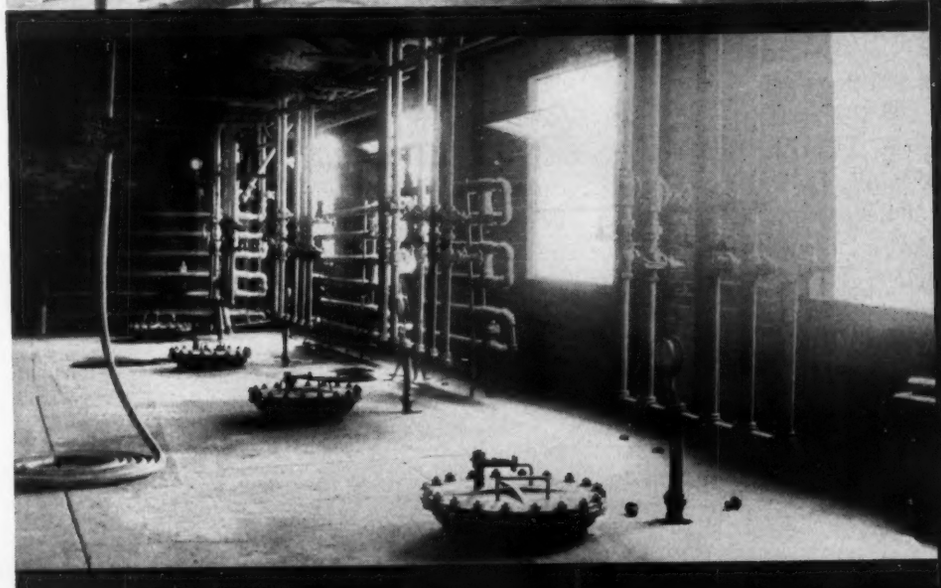


Vapor recovery plant which was built and operated as a "casing-head" plant before the refinery was erected

Agitator battery in Barnsdall refinery where the long residuum is contacted with 35 pounds of acid and neutralized with ammonia in first step of lube manufacture



Two-stage motor-driven compressor in direct expansion chillers used to secure low temperatures so that dewaxing can be accomplished by processing through centrifuges



Top of percolation filters

Tanks in which the finished bright stock is received after passing through the second contact filtration.

Kay Walworth valves.

Economies in Grease Making

F. E. HUGGINS, JR.
Dopp Sales Department,
Sowers Manufacturing Company

UNDER present competitive conditions alert managements are doing their utmost to improve the quality and/or the uniformity of their grease so as to increase their sales, and at the same time are reducing their costs wherever possible. Fortunately both objectives are attained by the use of cast-in-one-piece grease kettles whose seamless construction, smooth surface and true contour permit the use of positive scraping agitators.

Before pointing out the economy of this type of grease mixer it should be explained what is meant by "positive-scrapping" as applied to a mixer for grease or any other product. The word "scraper" has been loosely used to refer to any agitator that approximately follows the wall of a kettle, even if it clears the wall by ½-inch or more. By "positive-scraping" is meant an agitator having adjustable and renewable spring-tempered blades which actually scrape the walls, such as are incorporated in the design of Dopp kettles. They are almost parallel with the wall, and the wear from rubbing against the wall keeps them knife-sharp. They cut ahead of the agitator; do not drag against the wall. They press against the wall so hard that they will not ride over material deposited there, but keep the kettle wall scraped clean.

While wear keeps the scraper blades sharp, the worn-away metal has never been detected in grease or other material, and calculations show that the wear is so slow that it adds less than one part of metal per million parts of grease.

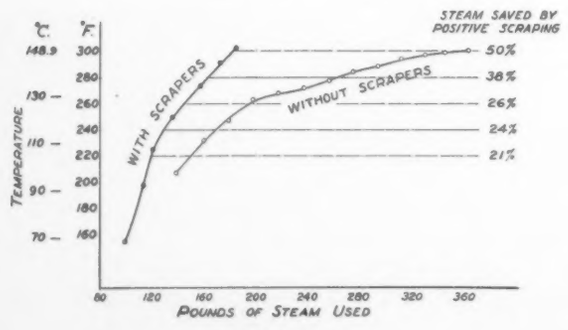


FIGURE 1

Among the economies made by these cast seamless, positively-scraped grease kettles are the following:

STEAM AND POWER SAVING

In a test run, grease was heated in a mixer without scrapers, weighing the steam that was condensed. This was repeated using the same mixer except with scrapers. Results are given by the curves in Figure 1 which show that when the grease was heated from 65° F. to 300° F. the scrapers saved 50 percent of the steam.

When heating the same grease from 80° F. to 274° F., with and without positive-scraping, a recording wattmeter connected to the motor driving the mixer gave the data in Figure 2. In this test positive-scraping made a power saving of 64 percent.

FIGURE 2

Contrary to what might be expected, these mixers also use less power because they are double-motion instead of single-motion type. Many of the older grease mixers were built with stationary "breaker" arms between which paddles revolved at usually about 40 revolutions per minute. In the double-motion mixer the part with scrapers and cross arms runs at 15 revolutions per minute, while a second set of paddles revolves in the opposite direction at 25 revolutions. The mixing action, as measured by the number of times one set of paddles passes the other, is the same, but it is so much easier to move paddles at low speed that the double motion mixer takes less power.

This was proved in a test with a 50-gallon double-motion mixer having its two sets of agitator blades driven separately by two motors, each with a meter

for measuring power consumed. When agitating a heavy grease, with inner paddles set at a constant speed of 16 revolutions per minute and taking a constant amount of power, it was found that reducing the speed of the outer sweep and its paddles from 30 revolutions per minute to 15 revolutions per minute reduced the power they consumed by more than 80 percent.

How this works out in practice is shown by the following: A grease manufacturer having 30-barrel single-motion mixers ordered a double-motion mixer of the same size, specifying a 15 horsepower drive. After installing it they wrote that "the rate of power consumed by the stirrer is approximately 2.3 kilowatts at full load." This is equivalent to approximately 3.1 horsepower, so based on their expectation that 15 horsepower would be required, the power saving made by the double-motion mixer was 79 percent.

TIME SAVING

The number of different greases which each manufacturer must now be in a position to supply, if he is to have a complete line, has increased year by year, yet, like everyone else, the grease manufacturer wants to keep down his inventory of finished goods and still be able to quickly fill orders. Sometimes this is carried to the point where no stock at all of certain greases is kept on hand but, by the use of time-saving methods and equipment, they are made only after they are ordered. Time savings in the manufacture of grease are therefore doubly important as they permit reduction of inventories and also reduce direct manufacturing costs.

HEATING AND COOLING

No comparison has been made of the times required for making grease with and without positive scraping, but when the grease used in the tests for steam and power savings previously referred to was heated from 80°F. to 274°F., with and without positive-scraping, the time saved by the scrapers, as shown by Figure 3, was 80 percent.

Cooling of the finished grease before packaging can be done in holding tanks, such as are still to be seen occasionally in grease plants, but this wastes a great deal of time. While the grease is in the holding tanks it is not continually agitated, because too long a period of agitation may break down the structure of the grease, giving it a low apparent consistency, with the result that the final true consistency may be higher than desired. On the the other hand if cooling is too slow there is the temptation to package it too hot, in which case the grease may have a false body, that in the center of the drum may be too soft when cold and, in the case of lime grease, shrinkage cracks may develop on cooling.

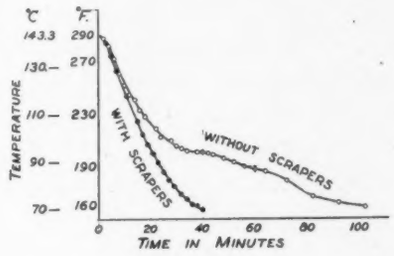


FIGURE 4

In cast seamless grease kettles the cooling is done in the same kettle in which the grease is made, by circulating cooling water through the jacket. These kettles withstand this severe service for there are no seams, joints, welds or rivets to open up and leak. This freedom from leaks is particularly important when making products such as soda grease which must be practically moisture-free, or aluminum stearate greases which are made cloudy by moisture.

When cooling a medium cup grease from 290°F. to 160°F., with and without positive-scraping, the curves of Figure 4 show a time saving due to scrapers of 62 percent.

How quickly the cooling may be done on a larger scale is shown by the fact that one grease manufacturer, in a kettle having 76.4 square feet of positively scraped surface, cools a 10 to 12 barrels batch of grease from 300°F. to 200° or 190°F. in about one hour in summer when cooling water enters the jacket at 70 to 80°F., or in about half an hour in winter when cooling water enters at 40 to 45°F.

When the grease has been cooled to the right temperature it is drawn off through a screen to remove foreign matter direct to the hopper of a can filling machine. This saves the space required and also the cost of holding tanks or mixers, together with the

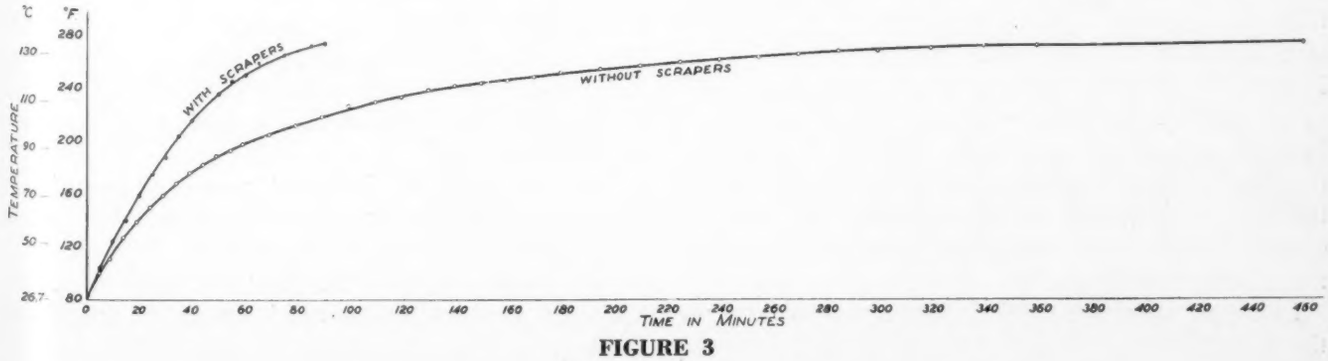


FIGURE 3

cost of their maintenance and operation; also speeds up the shipment of the finished grease.

ELIMINATING REWORKING

The grease is drawn out of the kettle and forced through the screen by a pump. One manufacturer using the flat or "dished" bottom steel grease kettles found that an average of about 800 pounds of grease stayed in each kettle after drawing off the batch and had to be worked over again. Processing grease costs approximately 1 cent per pound, so in a year (one batch per day for 300 days) this reworking amounted to approximately $2,400, practically all of which is saved by the use of round bottom kettles with positive-scraping agitators.

A further saving in the matter of kettle cleaning delays and costs is made by these positive-scraping mixers, for they keep themselves clean, operating month after month without manual cleaning of any kind. On the other hand there are non-scraping mixers which are shut down every two weeks while two men spend a full day using steel hand scrapers for removing material that has baked on the kettle wall, so that this crusty layer will not fall off into succeeding batches of grease and make a lumpy, inferior product.

PRESSURE MIXERS

The foregoing applies to positive-scraping mixers of both open and pressure types. The following savings apply to making the base under pressure and finishing it in an open kettle while another batch of base is being saponified under pressure.

The following reports from two users are typical of results obtained by all users: At one plant only one unsatisfactory batch was made during their first year's use of a pressure mixer, while before it was installed they had had a great deal of trouble with incomplete saponification. The bad batch had been held under pressure much longer than usual. They adopted a standard time for holding material under pressure and have not had this trouble again.

Another user has never found more than 0.1 percent uncombined fat, and that only a few times when using a fat which he advises is hard to saponify. This user said that regularly there is absolutely no uncombined fat, and that the beauty of a pressure mixer is that it eliminates all uncertainty and guess work—each batch is run the same way and the product is the same each time.

These pressure mixers are the same for either lime or soda base, in fact a grease manufacturer using his for both advises that it does not need to be cleaned when changing from one base to the other. The material remaining in a pressure mixer is only enough to give the agitator what might be described as a "fly specked" appearance.

These economies are all the more attractive when it is realized that these cast seamless grease kettles last practically indefinitely. With no welds or rivets to open up there is almost no upkeep and, while their design has been improved year after year, the writer has seen mixers of this type that are over 45 years old yet are giving just as satisfactory service as when new.

Automatic Machinery for Canning Oil

(*Continued from page 394*)

As the next empty can is placed on the table, the previously filled can is shoved onto the endless conveyor and is moving toward the capping machines. If quarts are being filled, they are taken care of at the first capper next to the filler. A removable arm is inserted in a slot in the frame so that as the filled cans travel down the conveyor, they are diverted to the endless conveyor leading to the capping machine.

Timing the arrival of the cans to the capping machine is controlled by a fluted roll which moves the filled container to a stripping device which in turn sets in motion the mechanism which removes a lid from the stack in the machine, places it in position and as the can is shoved under the press, the lid is dropped in place and rolled tight to the rim. An arm takes the completed can and slips it from its position under the press and throws it down a chute which directs the quarts upside down to the moving conveyor that takes them to the stenciling table.

Five-quart cans are handled in the same manner as the single quart containers but when filled, move to the second capping machine by removing the selecting arm from its slot and placing it near the machine designed to handle the larger cans. The action of the second machine is identical with that of the first, but moving more slowly because more time is consumed in filling the larger cans than is required for the quarts.

Operation and maintenance of the set of machines is relatively simple, but timing of the capping apparatus must be accurate. If the gear trains are tampered with and not placed back in the same condition, the action of the machines will quite likely damage or destroy the cans. Lubrication of most all of the moving parts is secured through placing soft grease in the journals with a grease gun, and numerous fittings are installed for this purpose.

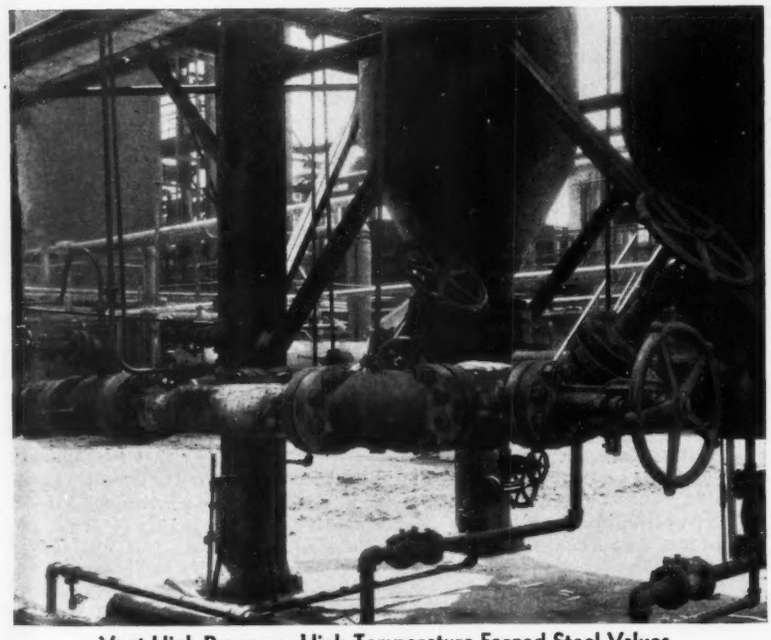
Both the quart and five-quart cans have been lithographed by the manufacturer, and as they arrive on the finishing table, this operator stencils the S. A. E. number on them and places the filled and finished can in cardboard boxes, seals them and stencils the weight on the box.

The Leader!

ON PARADE

Exhibit of Vogt Drop Forged Steel Valves at the International Petroleum Exposition in Tulsa.

ON STREAM



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SCIENCE AND TECHNOLOGY

Abstracts prepared in co-operation with the

REFINER AND NATURAL GASOLINE MANUFACTURER

by

THE LESLIE LABORATORIES

Traver Road, Ann Arbor, Mich.

under the supervision of

DR. E. H. LESLIE and DR. H. B. COATS

The abstracts here presented are selected from the current literature of science and technology to afford reference to fundamental information not easily available to all readers. Abstracts of articles appearing in readily obtainable trade journals are not included.

Photostat copies of original articles will be supplied at cost by the Leslie Laboratories. Complete or limited bibliographies covering special topics by title, by abstract, or in complete manuscript, will also be prepared and furnished at reasonable cost by the Laboratories.

Fundamental Physical Data

Phase Equilibria in Hydrocarbon Systems. IV. B. H. SAGE, W. N. LACEY AND J. G. SCHAAFSMA. *Ind. Eng. Chem.* **26** (1934) pp. 874-77.

The composition of a hydrocarbon gas has an important influence on the solubility of the gas in a hydrocarbon liquid. It has previously been indicated that variations in gas composition may be more important than variations in the composition of the liquid. The authors present the results of measurements of the solubility and resulting changes in properties when pure propane gas is brought to equilibrium with each of two oils at various temperatures from 70°F. to 200°F. and at pressures up to approximately 70% of the vapor pressure of propane at each temperature. The solubility of propane in an oil increases rapidly as its partial pressure approaches the vapor pressure of pure propane. The apparent specific gravity of the dissolved propane is greater than that of pure saturated propane liquid at the same temperature. The laws of ideal solutions appear to apply to propane rather closely when the gas is dissolved in crystal oil. The heat of solution of propane in crystal oil is comparable to the heat of condensation of propane at the lower part of the temperature range investigated, but is much larger than the heat of condensation as the critical temperature of propane is approached.

Tests for the Accuracy of Vapor-Liquid Equilibrium Data. H. A. BEATTY AND G. CALINGAERT. *Ind. Eng. Chem.* **26** (1934) pp. 904-9.

In a previous communication it was shown that when a binary system of volatile substances is ideal in character or nearly so, this fact can be demonstrated by a simple and accurate experimental method, and further, that in such cases the vapor-liquid equilibrium diagram can be calculated with great accuracy. In the case of systems that exhibit a significant deviation from ideality it is no longer possible to proceed in this manner, but becomes necessary to determine equilibrium data experimentally. Consequently it is important to have means of checking the reliability of the data so obtained. The accuracy of vapor-liquid equilibrium data for binary systems can be appraised by means of certain easily applied criteria derived from the Duhem-Margules equation. The data can be rigidly tested by a method based on this equation that depends on the calculation of one partial pressure curve from the other. The method and its application are elaborated graphically and mathematically and the application illustrated in several specific instances.

Calorimetric Determination of the Heats of Combustion of Ethane, Propane, Butane and Pentane. FREDERICK D. ROSSINI. *Bur. Standards J. Research* **12** (1934) pp. 735-50.

The following values were obtained for the heats of the reaction $C_nH_{2n+2}(g) + (3n/2 + ½)O_2\ (g) = n\ CO_2(g) + (n+1)H_2O$ (liq.), at 25° and a constant total pressure of 1 atm.: C_2H_6 (g), 1559.57 ± 0.44; C_3H_8 (g), 2219.57 ± 0.51; C_4H_{10} (g), 2877.88 ± 0.63; C_5H_{10} (g), 3536.00 ± 0.88, international kilojoules per mole. Converted to Cal[15] by means of the factor 1.00040/4.1850, these values are, respectively: 372.81 ± 0.11, 530.57 ± 0.12, 687.94 ± 0.15, 845.27 ± 0.21. The hitherto "best" values differ from the foregoing by the following amounts, respectively: —1.23%, —0.87%, no previous data, —0.86%. The hydrocarbons used in this study were so pure that their heats of combustion would differ from those of the pure substances by less than 0.01%.

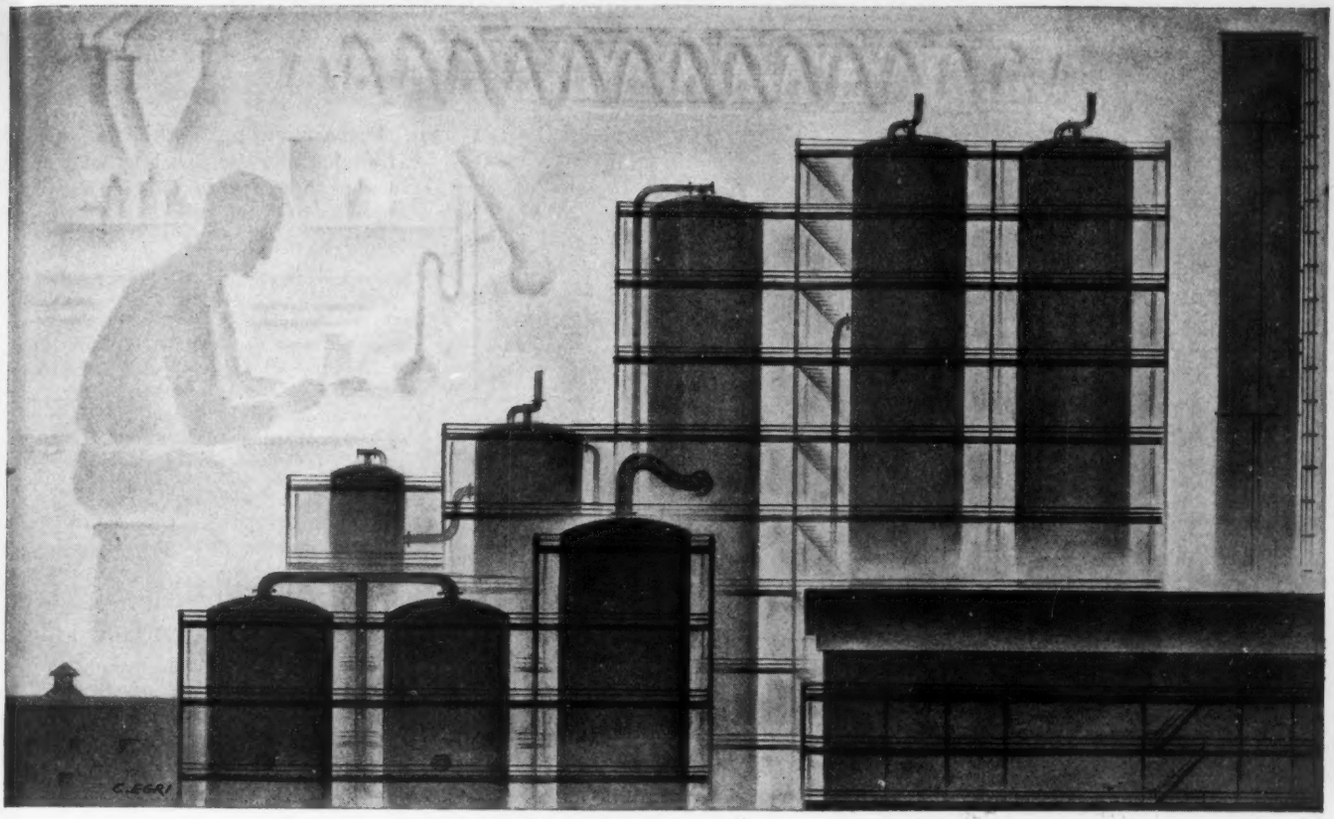
Chemical Composition and Reactions

Mechanism of Gum Formation in Cracked Gasoline. C. G. DRYER, C. D. LOWRY, JR., J. C. MORRELL AND G. EGLOFF. *Ind. Eng. Chem.* **26** (1934) pp. 885-88.

Previous work has shown that peroxides, aldehydes and acidic compounds can be detected in cracked gasoline as it deteriorates and forms gum. The authors have studied the rate of formation of these classes of substances in gasolines of several origins, some of them unrefined, some refined, and some containing inhibitors. The deterioration has been studied during storage for a period of one year. The analytical methods used for the determination of peroxides, aldehydes and acids are described. Peroxide can be detected early in the storage period when no aldehyde or acid and little gum is present. The rate of peroxide formation accelerates as time passes. Aldehyde begins to appear somewhat later and increases more gradually than peroxide. Acid formation begins still later and acid concentration increases more slowly than that of either aldehyde or peroxide. Gum begins to appear in quantity as soon as considerable peroxide has formed and before any large development of aldehyde or acid has taken place. The curve of gum content versus time is similar in shape to the peroxide curve, and the conclusion seems justifiable that gum formation is closely related to that of peroxide and that aldehyde and acid are products of secondary reaction rather than intermediates in gum formation. Inhibitors check the formation of all these products simultaneously, which indicates that they have a common origin.

The Equilibrium Constants of the Vapor-Phase Hydration of Ethylene, Propylene, and the Butylenes. H. M. STANLEY, J. E. YOVELL AND J. B. DYMOCK. *Jour. Soc. Chem. Ind.*, **53** (1934) 205T-208T.

by means of a flow method at atmospheric pressure, experimental determination has been made of the equilibrium constants of the reactions between steam and ethylene, propylene and butylene at temperatures between 150 and 250°C. and in the presence of active catalysts. With the exception of a few isolated determinations at somewhat elevated temperatures, little is known about the influence of temperature on the position of equilibrium in any of the reactions between olefins and water. Lack of these data is no doubt primarily the result of the fact that no really active catalysts have been found for the hydration of olefins, and accordingly, it has so far not been possible to approach equilibrium except at high temperatures where side reactions are appreciable. The authors have been fortunate in discovering active catalysts in the presence of which equilibrium may be approached at temperatures as low as 150°C. Catalysts employed, except in one instance, were acid phosphates containing manganese and boron. The values of the equilibrium constants diminished with rising temperature and thus all the hydration reactions are exothermic. Even at temperatures as low as 150°C. the equilibria are well over to the olefin side of the equation. Alchols are most easily formed from ethylene and least easily from the normal butylene. In hydrating propylene the main product is isopropyl alcohol, but small amounts



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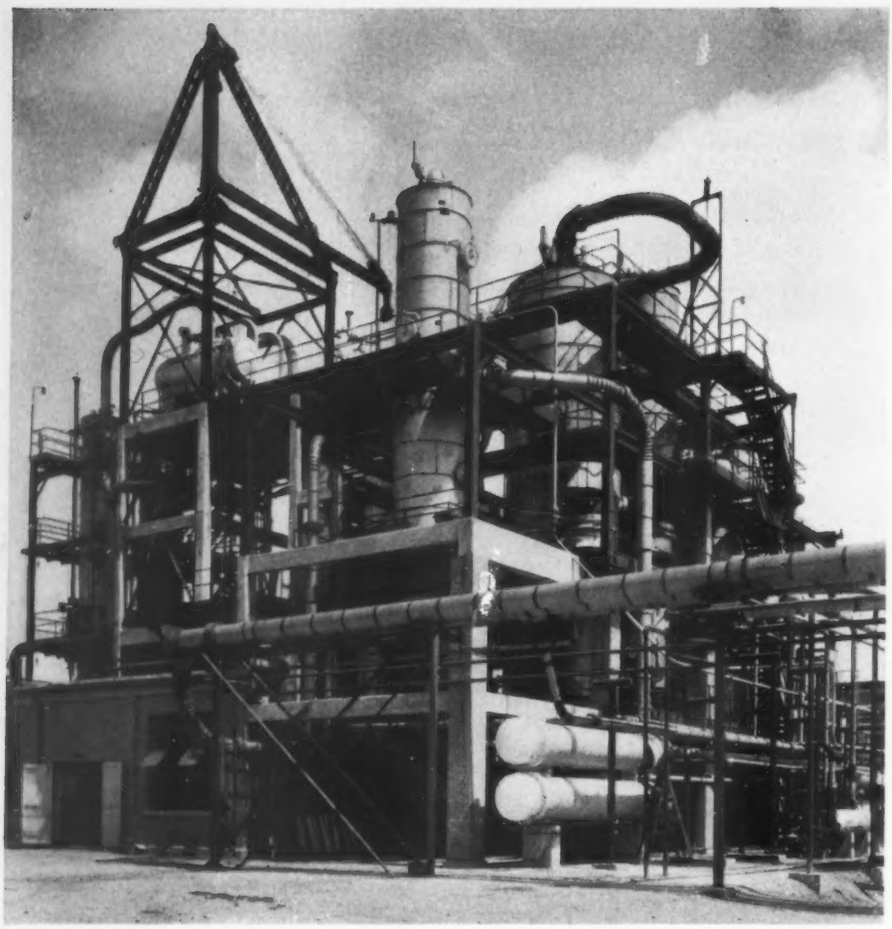

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of acetone and normal propyl alcohol were also produced. Alpha- and beta-butylene both yield normal butanol with the alcohol group in the beta position.

Preparation of Ethylene and Its Homologs by the Cracking of Heptane in the Presence of Water Vapor. C. MATIGNON AND M. SEON. *Compt. rend.* **198** (1934) pp. 1649-52.

In cracking heptane without the presence of water vapor, the maximum yield was 39% of ethylene homologs at 700°C. In the presence of water vapor in the ratio of 2 water vapor to 7.1 heptane by weight, a maximum yield of 65% was obtained at 800°C., of which 50% was ethylene. At 900°C. the ethylene increased to 74%. When the water-heptane ratio was 5.2 to 1, the ethylene yield was 76% at 935°C.

Rearrangement During Pyrolysis of the Butenes. C. D. HURD AND A. R. GOLDSBY. *Jour. Am. Chem. Soc.* **56** (1934) pp. 1812-15.

Gaseous decomposition products of 1-butene and 2-butene at 500-700°C. were studied. 2-butene was the more stable isomer. In both cases, especially at 650°C., extensive rearrangement occurred into the other isomer. No isobutylene was produced. The ratio of low boiling to high boiling 2-butene was practically unchanged during pyrolysis. More cis than trans isomer was found in the 2-butene produced from 1-butene. Experiments were included dealing with the identification of isobutylene and butadiene.

The Oxidation of Kerosene With Air. RUDOLF KLATT. *Petroleum Z.* **30** (1934) No. 12, pp. 1-6.

Kerosene vapors, along with air and steam, were passed through an electrically heated steel tube equipped with means for the rapid cooling of the reaction products in order to prevent secondary reaction. The catalysts used were manganese dioxide and vanadium pentoxide. It was concluded that the formation of water soluble acids was increased by decrease in temperature and in the flow of air and steam. Manganese dioxide causes cracking, while vanadium pentoxide has a favorable effect on the formation of acids, especially after continued use. The results of some preliminary batch experiments were contrary to the results obtained in continuous operation.

Mineral Oil Sulfonic Acids. II. A Color Reaction of the β-Sulfonic Acids. J. SEREDA. *Petroleum Z.* **30** (1934) No. 19, pp. 1-2.

β-sulfonic acids obtained as by-products from the treatment of petroleum fractions with concentrated sulfuric acid form ferric iron salts that are extractable with ether or amyl acetate to yield intense blue solutions characteristic of this class of acids. Naphthenic acid, α — and γ — and polysulfonic acids and the products of the treating of oils with fuming sulfuric acid react negatively in this test. By treatment with sodium sulfate, the salts are converted into water soluble sodium salts from which the blue ferric iron compounds are readily regenerated. The reaction is sensitive at concentrations as low as 0.2 milligrams of the sodium salt per liter and may be effected at a pH between 2 and 9.

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Manufacture: Processes and Plant

Heat Transfer from Saturated Steam to Transverse Surfaces. E. KIRSCHBAUM AND B. KRANZ. *Chem. Fabrik,* **7** (1934) pp. 176-180.

The heat transfer formula of Nusselt is based on the assumption of film condensation at the contact wall. Practically, however, both film and drop condensation occur, the latter being favored by the presence of oil. Using pure, quiet steam in a vertical copper tube, condensation was observed with the aid of an electric lamp and was found to be both in the form of film and drop. The results can be summarized by the equation: $\alpha_D = 8840 - 149t + 1565t^2$, where α_D is the heat-transfer coefficient and t the temperature difference. If α_N is the value calculated by Nusselt's equation, then the quotient $\alpha_D/\alpha_N = 2$ approximately. This ratio is raised to 6 by spraying in oil. Low wall temperature favors film condensation. For a wall temperature of 110°C., the temperature difference of 15, the ratio value 2 is correct.

Countercurrent and Multiple Extraction. T. W. EVANS. *Ind. Eng. Chem.* **26** (1934) pp. 860-64.

Extraction processes are becoming increasingly important to the petroleum refining industry. There are two general methods of operation: first, multiple extraction, in which the solution to be extracted is contacted with successive lots of fresh solvent, and second, true countercurrent absorption. It is recognized that of these two the latter is by far the more efficient, but at the same time more difficult to realize because of elaborate equipment requirements. The author reviews the literature of the subject and then presents graphical methods for the analysis of extraction problems, both multiple and countercurrent, and for immiscible and partially miscible solvents.

Tower Absorption Coefficients, VI. H. B. OSBORN, JR., AND C. W. SIMMONS. *Ind. Eng. Chem.* **26** (1934) pp. 856-7.

The authors studied the absorption of ethylene dichloride in paraffin in a counter-current absorption system. Absorption coefficients for a system comprising ethylene dichloride and paraffin were determined and were found to vary with the flow ratio in a manner such that the data yield a straight line on a logarithmic plot.

Small-Plant-Scale Liquid-Phase Hydrogenation Under High Pressure. G. CALINGAERT AND G. EDGAR. *Ind. Eng. Chem.* **26** (1934) pp. 878-80.

The authors describe a small plant for the hydrogenation of furfural to furfuryl alcohol. The process employed was a liquid phase hydrogenation under high pressure in the presence of a copper chromite catalyst. The difficulties in the preparation of the catalyst, necessity of operation at moderate temperature with a very active catalyst, and the importance of sufficiency of stirring in liquid-gas reactions are described. Furfuryl alcohol of high purity was prepared at a temperature of approximately 175°C. and at 50-100 atmospheres pressure.

Scientific Principles of Cracking Under Pressure. A. SACHANEN. *Erdol u. Teer,* **10** (1934) pp. 105-107, 115-117, 131-132.

The author generally discusses the nature of the cracking process, dealing first with the in-

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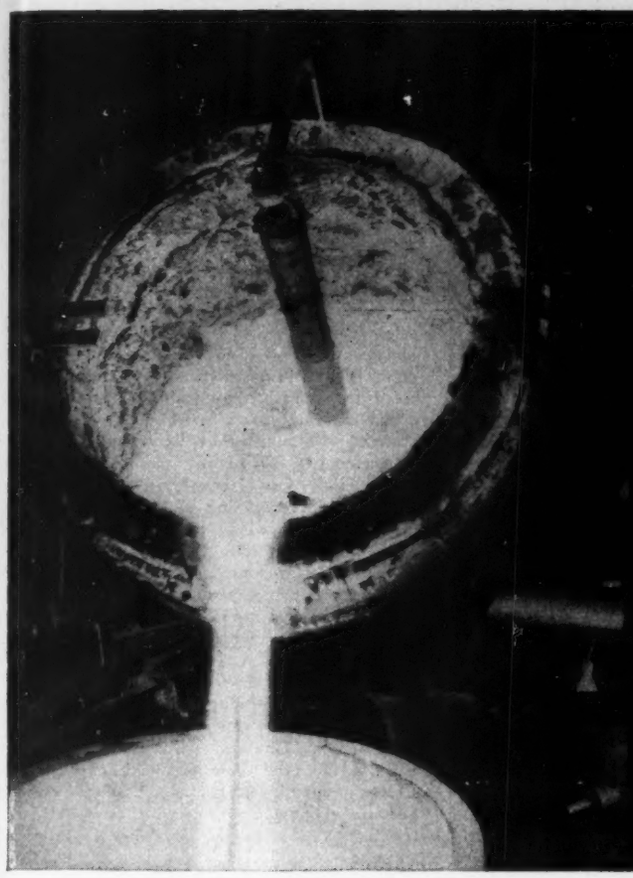
fluence of time, temperature and pressure on the yields of gasoline and coke. The nature of the charging stock is of great importance, lighter oils yielding more gasoline and less coke than the heavier oils under the same conditions. Pressure has no direct effect on yield or speed of reaction, but is of importance because of its influence on the volume of products to be handled through the apparatus and in regard to heat transfer, which is favored by high pressure. Very high pressures are not necessary and are bad for the apparatus. The decomposition of the gasoline formed may be serious if it is not removed from the reaction zone. At 425°C. the decomposition is approximately 3% per hour. The amount increases as the yield of gasoline increases. From a 50% possible yield per cycle, approximately 41% of product is obtained and 9% is decomposed. However, with cycle yields up to 20%, decomposition is not ordinarily important. The formation of coke depends largely on the boiling point and nature of the charge stock. Paraffin wax yields up to 60% of gasoline before coke formation starts, but residuum begins to yield coke almost at once, that is, from 2% yield on up. Coke formation starts sooner upon recycling, and the ratio of residue to gasoline increases with each cycle. The maximum gasoline yield for a recycling process with coke formation is 60% for gas oil and 50% for paraffin distillate. The number of recycles in commercial processes varies from two to six. Numerous tables are given, showing the influence of conditions on yield and results. Reforming is discussed, and it is well known that the higher the octane number of the final product, the less the yield. In a specific instance, a naphtha of 32 octane number was reformed to yield 90% of gasoline of 67 octane number, or 75% of gasoline of 82 octane number. Data are given on conditions of operation and throughputs of various commercial cracking plants.

Prospects of a Petroleum Chemical Industry. CARLETON ELLIS. *Ind. Eng. Chem.* **26** (1934) pp. 826-36.

The article reviews the expanding knowledge of the chemistry of petroleum and some of the more important efforts to utilize this natural raw material in the making of a large number of new chemicals and products. Prospects of a more extensive chemical industry of this type are discussed. Alcohols produced on a commercial scale by the sulfuric acid process are ethyl, isopropyl, secondary and tertiary butyl, secondary amyl, and secondary hexyl. Work on the direct hydration of the olefins has as yet not been successful commercially. The direct production of esters by passing of the olefins through the organic acids containing sulfuric acid is being developed. Acetone is made by the dehydration of isopropyl alcohol. Glycols and olefin oxides are made by first forming the chlorohydrin through the reaction of hypochlorous acid with olefins. Ethylene dichloride is made by the direct addition of chlorine to ethylene. An interesting product made from ethylene chloride is thiokol, produced through the reaction of ethylene dichloride and polysulfides of the alkali or alkaline earth metals. Thiokol resembles soft rubber and is practically insoluble in all organic liquids. Glycol is useful as a solvent and anti-freeze. Higher boiling materials, such as the polyglycols, are formed as by-products in making glycol. These substances have proved to be almost ideal lubricants for wool spinning. Ethylene oxide and the alkaline oxides generally react with organic substances containing an easily replaceable hydrogen atom, for example, alcohols, acids, phenols and amines, and also with water. For example, the glycol monoethers are made by the reaction of ethylene oxide and an alcohol. They



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Products: Properties and Utilization

What Is Oiliness? O. C. BRIDGEMAN. *Physics, 5* (1934) pp. 125-30.

Oiliness is the characteristic of liquids that results in a lowering of the fricton between two surfaces that cannot be explained on the basis of the viscosity of the liquids. In order to separate the effects of oiliness and viscosity, McKee's formula for friction in a journal bearing is applied. This equation is $f = a + k(ZN/P)$, where f is the friction coefficient; Z, the absolute viscosity; N, the journal speed; P, the applied load per unit of projected area, with a and k bearing constants. It is shown that if f is plotted against ZN or ZN/P, the results for castor, lard and mineral oils all lie on the same curve in the region of thick film lubrication, and that in this region oiliness has no effect. The region of thin film lubrication was explored by use of a special friction testing machine, and the McKee function is shown to account for the effects of viscosity. Friction curves for castor and lard oils show the effect of oiliness at low speeds. The curves for all oils tend to merge at higher running speeds, but it is clear that the ZN plot permits direct comparison of fatty and mineral oils and separates the viscosity and oiliness effects. It is indicated that the compostion of the metal surfaces has a marked effect on oiliness in the region of thin film lubrication.

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ternal Combustion Engines, Part II. H. N. BASSETT. *Gas & Oil Power*, 29 (1934) p. 138.

The addition of fatty oils or fatty acids increases the rate of deposition of carbon slightly and tends to make the carbon deposits sticky. Dewaxing usually increases the carbon residue of an oil. However, the addition of Paraflow does not affect carbon formation. The addition of cylinder stock to neutral or distillate oils, although improving the oils from the usual specification standpoint, definitely increases carbon formation. That portion of the oil that is in the form of mist in the crankcase is extensively oxidized and forms the larger part of the asphaltic substances responsible for carbon formation. Oxidation of the oil in the liquid state is slower. The extent of the carbon deposits depends on the amount of oil forced into the cylinder. Use of anti-oxidants is promising in preventing oxidation of the oil. Tests in a motorcycle engine driven hard for 500 miles showed that the addition of 1% by weight of ethyl fluid reduced carbon formation. The crankcase oil retained its original color and was free from sludge and deposits. Over-lubrication is another important cause of carbon deposits, and in this category also are dirty air, dirty fuel, unsuitable fuel and incomplete combustion.

The Behavior of Lubricating Oils in Motors. RUDOLF OREL. *Petroleum Z.* 30, No. 15, *Motorenbetrieb und Maschinen-Schmierung* 7, No. 4, (1934) pp. 2-7.

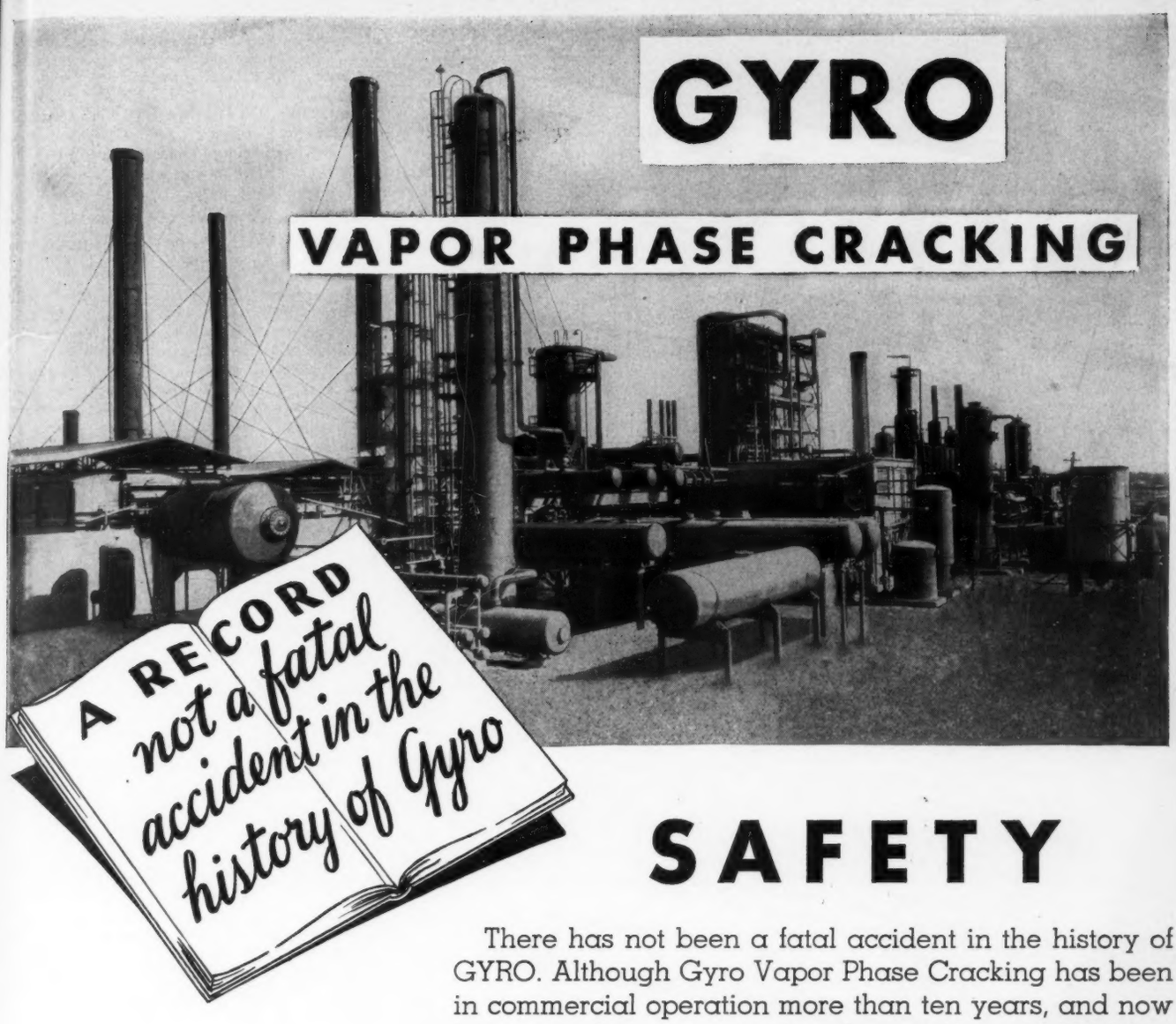
Lubricating oil decreases in value with use because of loss of viscosity, formation of sludge and introduction of impurities. The decrease in viscosity is rapid at first, then becomes slower, and finally the viscosity becomes constant or even rises. Viscosity loss occasioned by dilution at this stage is balanced by increase resulting from sludge formation. The introduction of impurities is nearly constant during the whole period of driving. The diluting naphtha boils at 100-200°C. and its olefin content is greater than that of the motor fuel used. The writer concludes that the best temperature for the cooling water is 70°C. In a test in which hydrogen was used as fuel, it was discovered by measuring the carbon dioxide in the exhaust gas, that 30-50% of the lubricating oil lost was burned.

Viscosity of Esters of Saturated Aliphatic Acids. Relation to the Synthesis of Fine Lubricating Oils. A. H. GILL AND F. P. DEXTER, JR. *Ind. Eng. Chem.* **26** (1934) p. 881.

Porpoise jaw oil has been used for almost a hundred years for the oiling of the finest and most delicate machinery such as clocks. Its lack of change in the air, low viscosity and high lubricating value makes it especially suitable for this purpose. However, it is expensive, costing at times $60 per gallon. The oil has been found to be composed of about 60% isovalerin, 6% tripalmitin, 4% triolein, 3% free isovaleric acid, and 27% dodecyl isovalerate. It is believed that a satisfactory substitute can be made largely from the liquid wax dodecyl valerate. However, this ester would be expensive to prepare. Viscosities of other esters were therefore studied. Viscosities of the various esters containing the same number of carbon atoms are fairly close to each other.

Oiling Earth Roads. HANS F. WINTERKORN. *Ind. Eng. Chem.* **26** (1934) pp. 815-19.

The factors affecting the qualities of oiled dirt roads are examined theoretically and experimentally. New surface treatments tried and the experimental oiling of roads are described. In all instances it was found that the addition of



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water and of surface-active substances, such as soaps, improve the character of the final road. However, it is necessary to consider the properties, such as clay content and organic matter content, of the soil to be treated. A new method of making and applying road oil emulsions has been developed that promises to be useful in future road construction.

The Foundry Use of Processed Petroleum Coke. CLARK B. CARPENTER. *Mech. Eng.* **56** (1934) p. 330.

Petroleum coke, processed by coking-still residues in gas retorts, compares favorably with coke from coal in so far as the criteria of laboratory tests are concerned, with the exception of porosity, which is 37-40%. Using this coke in the cupola, the silica loss in the iron is 30-40% less than normal. No apparent saving in manganese is effected, and the temperature of the iron at the spout is increased. If a ratio much below 10 to 1 in the cupola was used, "kish" appears in the iron. This type of coke is now being successfully used in making all grades of iron.

Natural Gas and Natural Gasoline

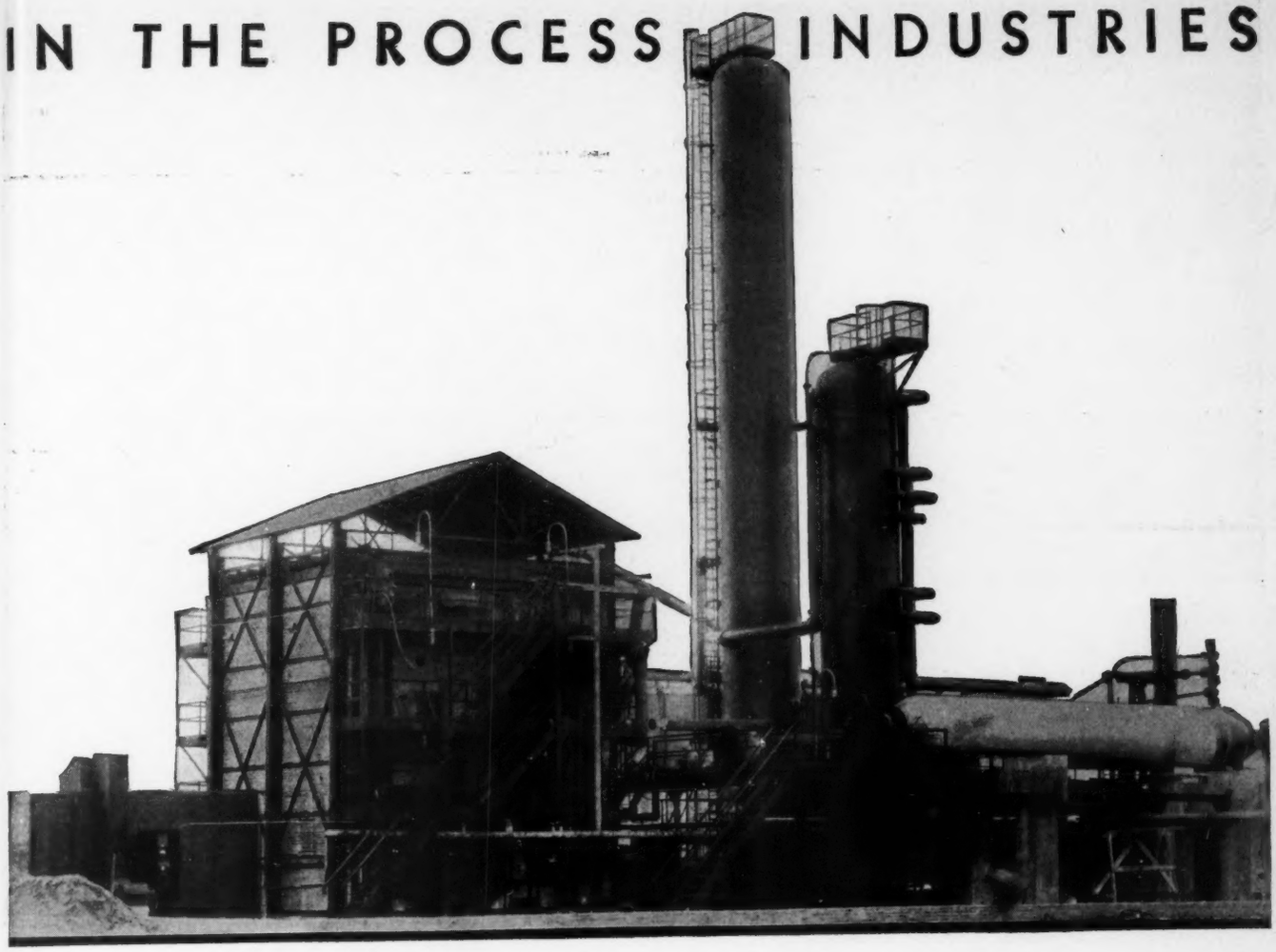
Formation of Gas Hydrates in Natural Gas Transmission Lines. E. G. HAMMERSCHMIDT. *Ind. Eng. Chem.* **26** (1934) pp. 851-55.

The presence of water vapor in natural gas has been a source of trouble in the measurement and transportation of the gas. A white solid resembling snow in appearance collects in the pipe line and will eventually cause stoppage. It has been determined that this white snow-like solid is composed of hydrates of the hydrocarbons. The melting point of these mixed hydrates in a natural gas mixture depends upon the pressure and varies from about 34° at 110 pounds to 60° at 800 pounds. The formation of the gas hydrates depends primarily upon the pressure, temperature and composition of the gas-water vapor mixture. The formation of hydrates is accelerated by high velocities of the gas stream, pressure pulsation or inoculation with a crystal of the hydrate. The vapor pressure of the hydrates is lower than that of water, and hence they cause more water to be removed from the gas phase than would be the case if the removal of water vapor were to form liquid water at the same temperature and pressure. The subject of gas hydrate formation is reviewed, the experimental apparatus used in the study of these compounds described, and the data secured in the experimental work given.

Natural Gas as a Source of Benzene. K. KAFUKU. *J. Fuel Soc. Japan,* **13** (1934) pp. 38-40.

The formation of benzene from natural gas was studied by passing the gas through silica tubes of different diameters, heated in an electric furnace. The yield of liquid products varied with the time, and the optimum velocity depended on the diameter of the reaction tube, the larger the diameter, the higher the yield. The decomposition of methane is proportional to the hydrogen content of the final gas. The final gas contained acetylene, ethylene, butane and light oil, which oil contained approximately 95% of benzene. The maximum yield of aromatic hydrocarbons was obtained at 1000-1050°C. One thousand cubic feet of natural gas containing 94% of methane yielded 3.5 kilograms of polymerized oil. It is claimed that the production of benzene from natural gas has industrial possibilities, provided the end gas can be used profitably for power generation.

IN THE PROCESS INDUSTRIES



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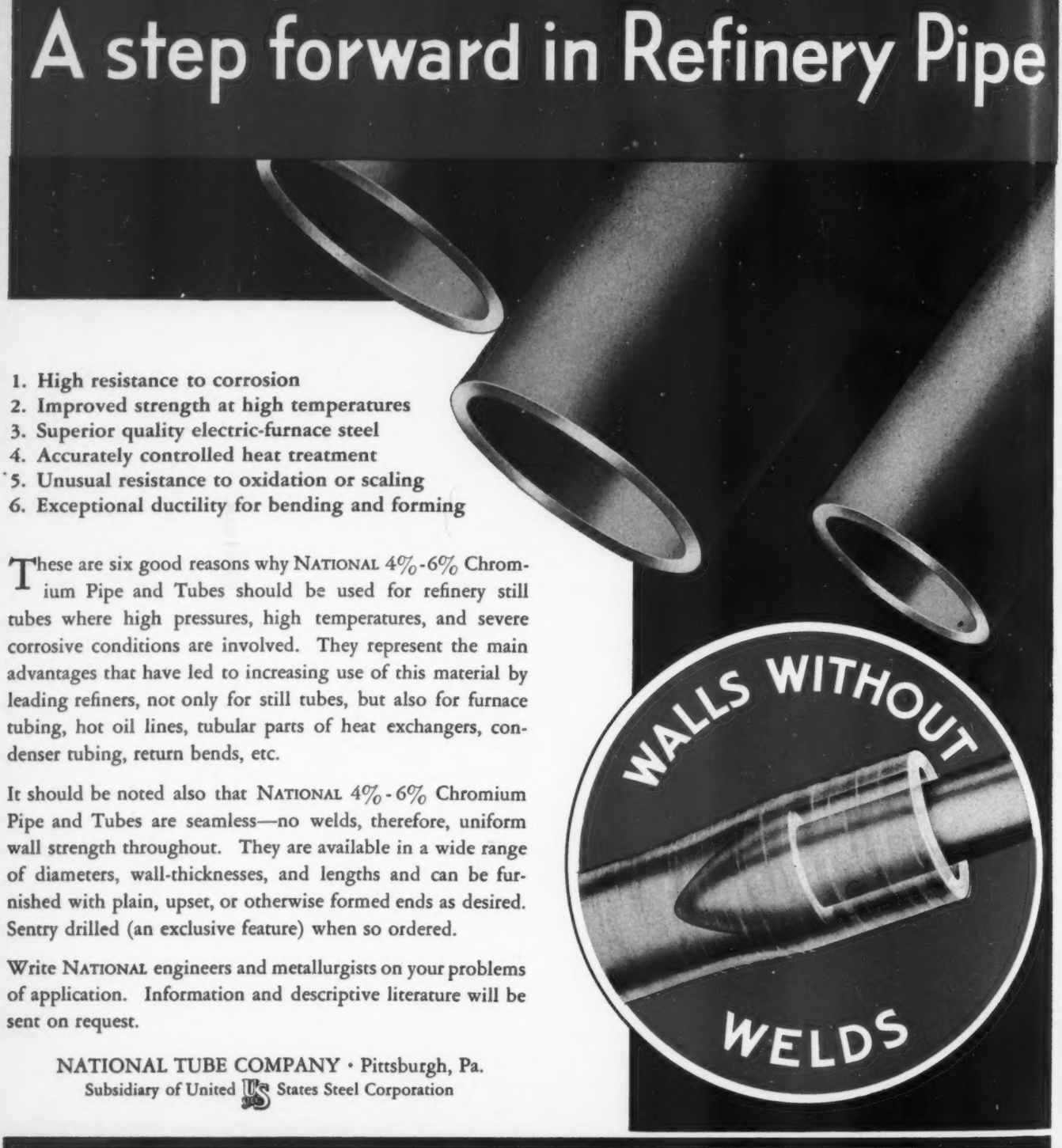

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THE MONTH IN REVIEW

A.P.I. Annual Meeting In Dallas

DALLAS, Texas, will be the meeting place of oil men from all parts of the United States when the fifteenth annual meeting of the American Petroleum Institute convenes November 13, 1934.

Tentative plans for the three-day conference were announced by William R. Boyd September 22. A meeting of the board of councillors and a general session of the Institute will mark the opening day. On Wednesday, November 14, and Thursday, November 15, meetings of the production, refining, and marketing divisions will be held. On Thursday evening the annual dinner of the Institute will be held.

The board of directors are scheduled to meet daily from Monday, November 12, to Thursday, November 15, inclusive, while an executive committee meeting will be held November 15.

Refinery Gasoline Allocation for October

THE allowed production of gasoline by refinery districts (including the production of straight run and cracked gasoline and the natural gasoline blended therewith, either at refineries or terminals) has been determined, in accordance with Section 3, Article IV, of the code, to be, for the month of October, 1934, as follows:

District—	Amount (42 Gal. Bbls.)
1. East Coast	5,603,000
2. Appalachian	1,416,000
3. Indiana-Illinois-Kentucky	5,993,000
4. Oklahoma-Kansas-Missouri	4,620,000
5. Texas:	
(a) Inland Texas	2,524,000
(b) Texas Gulf Coast	6,765,000
6. Louisiana-Arkansas:	
(a) Louisiana Gulf Coast including Alabama	1,095,000
(b) North Louisiana-Arkansas including Mississippi	799,000
7. Rocky Mountain	765,000
8. California	4,110,000
Total United States	33,690,000

October Allowable Production Decreased

A DECREASE of 15,900 barrels daily in the national allowable production of crude oil was authorized by Secretary of the Interior Harold L. Ickes, the Oil Administrator, in fixing the October total of 2,325,800 barrels daily, as compared with 2,341,700 barrels for September.

The slight decrease is due to normal seasonal decline in gasoline consumption, and the continued necessity for reducing excessive gasoline inventories, which are still above a sound economic level.

The bulk of the decrease was borne by four states, as follows: Texas, 12,300 barrels daily; California, 4700 barrels; Oklahoma, 3600 barrels, and Michigan, 300 barrels. Increases in daily allowable production were permitted as follows: Arkansas, 900 barrels; Kansas, 3000 barrels; and Louisiana, 1100 barrels. Allocations of all other oil producing states remained unchanged.

National Petroleum Association Re-elects

CHARLES L. SUHR, president of the Pennzoil Company, Oil City, Pennsylvania, was reelected president of the National Petroleum Association at its annual meeting in Atlantic City, September 19-21. All other officers of the association will continue in the same positions they have held during the past year. The complete list of officers follows:

President—Charles L. Suhr, Pennzoil Company; first vice president—N. H. Weber, Pure Oil Company; second vice president—H. A. Logan, United Refining Corporation; treasurer—G. B. Hunter, Quaker City Oil Refining Corporation; recording secretary—H. G. Eaton, Superior Oil Works.

Board of Trustees

R. G. Van der Woude, Shell Petroleum Corporation; P. G. Blazer, Ashland Refining Company; G. B. Hunter, Quaker State Oil Refining Corporation; H. L. Lewis, Conewango Refining Company; J. A. Beck, Pennsylvania Refining Company; H. M. Carruth, Canfield Oil Company; Sheldon Clark, Sinclair Refining Company; Earle M. Craig, Freedom Oil Works Company; Frank B. Fretter, National Refining Company; W. V. Hartmann, Gulf Refining Company; W. T. Holliday, Standard Oil Company of Ohio; Otto Koch, Kendall Refining Company; C. J. Leroux, Valvoline Oil Company; H. A. Logan, United Refining Company.

E. M. Lyons, Tiona Refining Company; A. W. Scott, Wolverine-Empire Company; C. G. Sheffield, Standard Oil Company of New Jersey; Charles L. Suhr, Pennzoil Company; N. H. Weber, Pure Oil Company; A. C. Woodman, and R. A. Wotowitch, Crew-Levick Company.

Washington Staff (Appointed by the Board of Trustees)

General counsel—Fayette B. Dow; associate counsel—Willis Crane; attorney—Horace L. Lohnes; traffic attorney—Harry S. Elkins.

New Chairman Announced By A.P.I. Tank Committee

A MEETING of the main Tank Committee of the American Petroleum Institute will be held in Dallas, Texas, during the fifteenth annual meeting of the institute, that organization's Division of Production has announced.

J. H. Wood, Jr., of Atlantic Pipe Line Company, Dallas, has been appointed national secretary of the Committee on the Standardization of Steel Tanks for Oil Storage, replacing W. C. Shutts, resigned.

H. M. Stevenson of Humble Pipe Line Company, Houston, has been named chairman of the southwestern district sub-committee, and W. M. Griffin of Shell Oil Company, San Francisco, has been made chairman of the California district sub-committee and chairman of the engineering sub-committee, C. A. Young, secretary of the committee, has announced.

The Manufacturers' sub-committee on bolted tanks will have William Schwemlein of The Parkersburg Rig & Reel Company, Parkersburg, West Virginia, as its new chairman. Mr. Schwemlein replaces L. N. Slater, who resigned.

A.S.T.M. Work On Petroleum Products

AMERICAN Society for Testing Materials Committee D-2 on Petroleum Products and Lubricants has a number of important projects under way. Various corrosion tests for lubricating oils are being studied with the expectation that a standardized procedure may be recommended. Methods for determining softening point of greases and for the consistency of soft greases are being drafted.

The subcommittee on viscosity is continuing its study of methods of expressing viscosity-temperature relationships, and will attempt to develop a method of determining the viscosities of lubricating oil at 0 F. and also a method for determining true viscosity

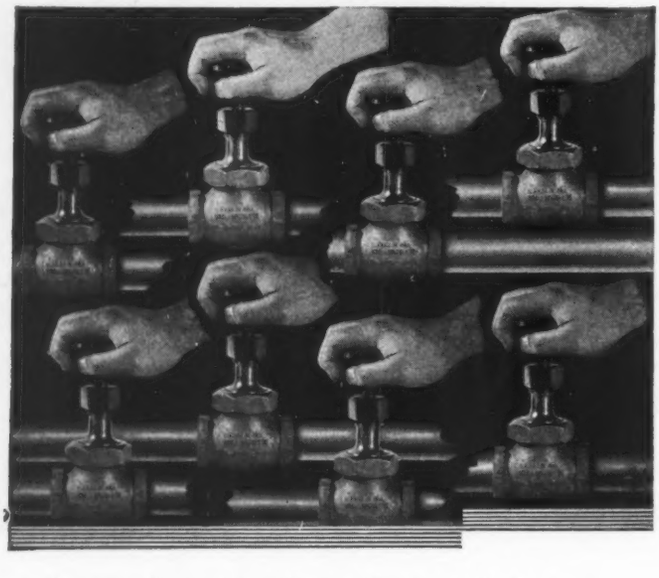
of certain plastic and semiplastic oils.

The committee is working on a method for the more accurate measurement of the flash point of viscous liquids, especially cut-back asphalts and suspensions of solids, than is now possible with any of the three standard methods, namely, the open-cup method (D 92), the Pensky-Martens closed tester (D 93) and the Tag closed tester (D 56). The subcommittee has developed a modification of the Standard Method of Test for Flash Point by means of the Pensky-Martens Closed Tester (D 93-22) to permit of a better control of the rate of heating and a rapid, continuous stirring of the material being tested.

In cooperation with the National Association of Lubricating Manufacturers and the Society of Automotive Engineers, Committee D-2 is working to develop a classification for automotive greases.

The subgroup on gasoline is active in developing a standard method of testing gum stability of gasoline. Various accelerated oxidation tests have been studied and comparative data obtained from several cooperating laboratories. Based on this, the committee is developing an improved design of apparatus. The development of a uniform bomb test apparatus is a necessary step toward the study of the significance of oxidation test as regards storage. In this work consideration will also be given to the glass bomb (Voorhees) test with which an extensive amount of correlation work has been done. Another part of the program includes a consideration of the copper dish test, which, in spite of definite drawbacks, is used to considerable extent in evaluating stability.

Why Use Your Hands?



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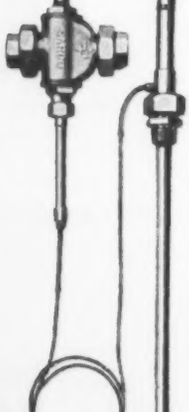

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A.P.I. Publishes Petroleum Bibliography

A LIST of articles on the petroleum industry and its products, which were published during the first six months of 1934 in magazines, trade journals, and in pamphlet form, has been prepared by the American Petroleum Institute for the use of editors, students, research workers, and others to whom a list of articles on the current developments of the petroleum industry is helpful.

The bibliography contains sections devoted to refining, marketing, transportation and storage, highway transportation and maintenance, aerial transportation, taxation, federal control and legislation, legislation and legal decisions, general articles and biography.

Its chief interest is to provide ready access to recent material on these subjects. According to the announcement made by the institute, the compilation makes no pretense of selecting articles on the basis of merit, of being 100 percent complete, or of supplanting or competing with any other published bibliography.

New Quantity Prices on Refinery "Flow Charts"

THE American Petroleum Institute has announced new prices covering quantity orders of the colored "flow chart" which it recently published. From one to 100 copies may be obtained at five cents each; 101 to 500 copies at four cents each; and 501 to 1000 at three and one half cents apiece.

The "flow chart" is 17 by 22 inches in size, and breaks down the intricate process of refining crude oil into a comparatively simple form, understandable to the student or layman. In addition to showing the major refining operations, a map of the large oil fields of the United States is shown. In ordering, address the Institute's Department of Public Relations, Room 2040, 50 West 50th Street, New York.

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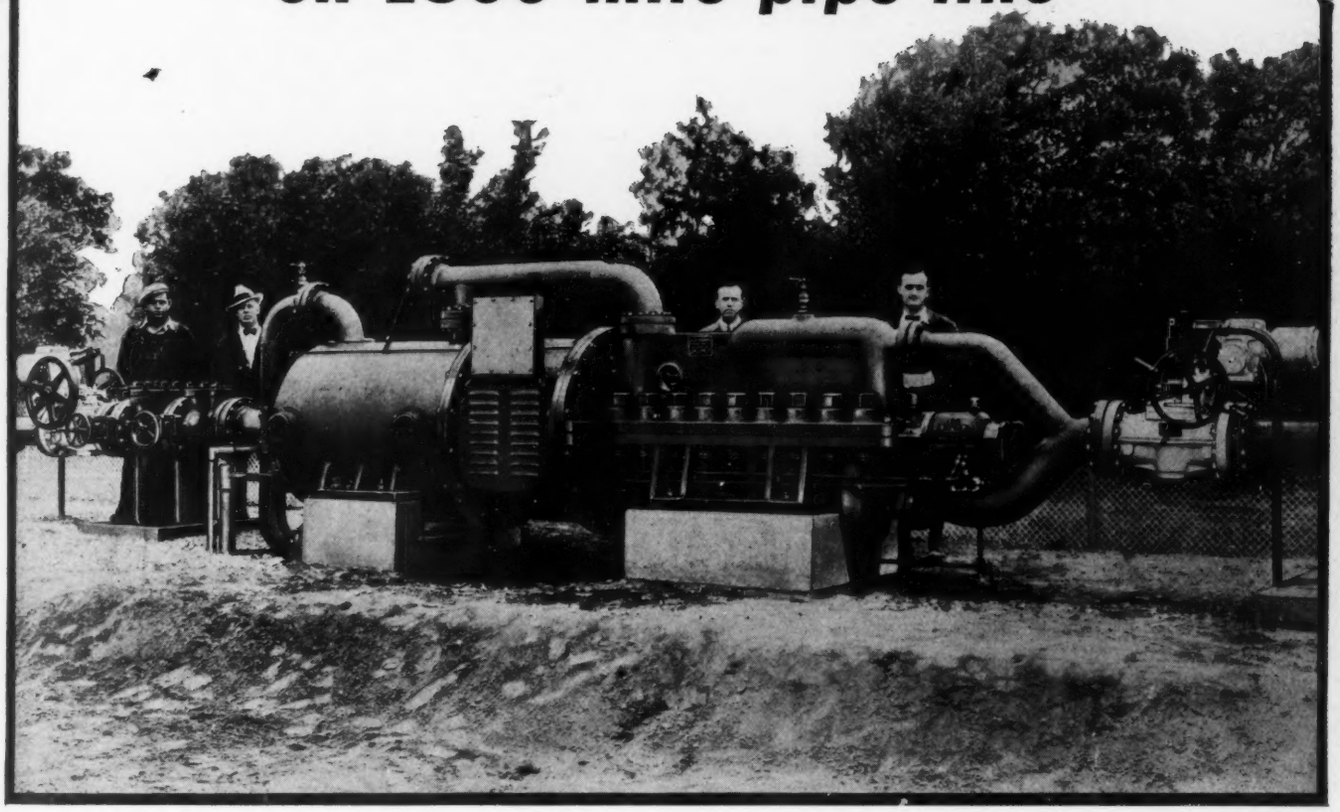

Greater Strength and Reduced Weight of New "Rannett" Pumps due to Nickel Cast Iron

THE photograph shows one of the new type Rannett electrically driven centrifugal pumps. This and twelve others like it are now in service on the 1500 mile stretch of the Great Lakes Pipe Line Company.

The Allis-Chalmers Manufacturing Company of Milwaukee have incorporated several unique features in these pumps. They are hermetically sealed—weatherproof and dirtproof so that they may be used without housing of any kind. The motor is cooled by the liquid which is being pumped.

Still another point of interest is the use of Nickel Cast Iron in the casing and wearing rings, which results in improved strength, toughness and density. Weight is also reduced... the 19-foot Rannett unit weighs only 26,000 pounds. It can be assembled at the manufacturer's plant and shipped ready for immediate use. The Allis-Chalmers people have had more than ten years experience with Nickel Cast Iron. During that period thousands of tons have been turned out. Chief chemist R. S. Macpherran of the Allis-Chalmers foundry states that the use of Nickel as an alloy facilitates machining, increases Brinell hardness and tensile strength.

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TO become a satisfactory fuel for domestic consumption propane must not only be practically pure and free from heavier hydrocarbons, but must not contain moisture which will settle out in the containers or bottles after they are filled. The liquid propane must also be "sweet" and non-corrosive to avoid fouling of regulators, sticking of control valves and damage to burners.

In finishing this product Skelly Oil Company chemically treats it with caustic soda and sodium plumbite solution and separates all moisture in one continuous operation through a battery of five small columns operating in series. The first two columns in the series are used for contacting the propane with caustic and sodium plumbite. The first tower is operated by taking a split stream from the main gasoline caustic treating pump and circulating this chemical through the column. Propane passes from the base of the column to the top outlet, contacting the caustic in its upward flow and in this manner any hydrogen sulfide present is removed. Passing to the next column, a split stream of sodium plumbite which is also taken from one of the main treating plant pumps, is circulated counter-current to the flow of propane. It is sweetened in this column but a small quantity of the chemical remains in suspension. The third column is used as a settling tower or scrubber for the removal of suspended chemical.

The fourth column in the series is termed the "drier." This tower is constructed with two removable flanged openings, one at the top and the other as a manhole placed near the base. To prepare it for operation, both openings are unflanged and all material inside of the tower is removed. The lower opening is securely closed and the column is filled with unslaked lime through the opening at the top. The unslaked lime absorbs and removes water from the propane as it passes upward through the irregular chunks and pieces. The amount of lime necessary for operating the drier depends upon the volume of propane being treated and its condition when it enters the column after leaving the scrubber. When it is necessary to refill the drier with lime, both flanges are removed and the spent lime removed and fresh material is added. As the propane leaves the drier column, it enters a final scrubber column, installed to prevent any lime or other substance from passing to the storage tanks.

Government Control Strongly Opposed

WITH the investigation of the oil industry by the Cole committee suspended until after the elections, observers in Washington were evaluating the results of the six days of hearings at which members of the Oil Administration and leaders of the industry presented their views on the desirability of placing the federal government in full control of production.

While officials take the view that the opposition presented little in the way of valid argument against Administrator Harold L. Ickes' ambitious plan to clamp a rigid control upon the industry, less interested observers believe that the hearings developed the existence of an unbridgable gulf between proponents and antagonists of federal control.

The element of uncertainty, injected by charges that "conservation" was merely either another name or a screen for "price control," may prove to be an important factor in the decision of the committee, members of which already have indicated their lack of sympathy with Mr. Ickes' plans.

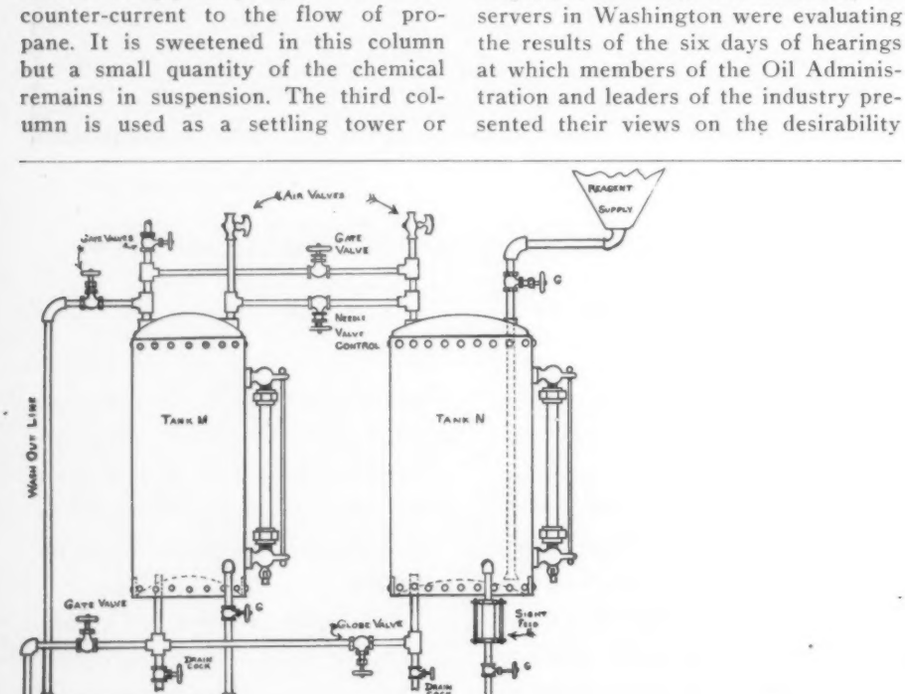
Apparently in approval of the premise that, to achieve any stability in the industry, the movement of hot oil must be curbed, committee members appeared reluctant to invade the rights of the states.

It is pointed out that the Oil Administration stood practically alone in its fight for strict government control, with the leaders of the industry, labor and, by inference, the consuming public, aligned solidly against anything which might develop into monopoly, howsoever designated, with its limitations of production, heavy costs of administration and consequent high prices.

The case against government control of industry was made even stronger by the attack, while the hearings were in progress, of the American Trade Association Executives against the NRA and code control which they declared was retarding recovery. Involved codes, it was contended, are proving impossible of administration, have served to bring about unwarranted increases in prices and have slowed down the wheels of industry.

This attack followed the submission to the President by the National Association of Boot and Shoe Manufacturers and the code authority for the shoe manufacturing industry of a recommendation that all provisions other than those dealing with labor be eliminated from all codes. The shoe industry took the stand that trade practice and other provisions were unworkable.

A significant feature of the hearings last week was the omission of all reference to the mill taxes provided by the 1934 Revenue Act, which were urged by Administrator Ickes as affording the machinery whereby the production control provisions of the oil code could be made fully effective. Those taxes have not been in operation long enough to permit a determination as to their effect, but there appeared a tendency on the part of some members of the committee to use all present means of enforcement before undertaking any drastic steps which would require the policing of every well, in the flush production areas, at least.



Skelly Gas Treater

Retail Price Is Low When Gas Tax Is Reasonable

ON September 1, 1934, the average price of gasoline in the United States was 19¼ cents per gallon including the average federal and state tax of 5¼ cents. This was the same as in the previous month, August, and one third of a cent more than the price one year ago, according to figures obtained by the American Petroleum Industries Committee. They cover retail gasoline prices and taxes in 50 representative cities located in every state of the Union and the District of Columbia.

The figures show that retail gasoline prices are low when the gas tax rate is reasonable and rise as the tax increases. With one exception, prices were lowest in the group of cities with the lowest tax rate and rose gradually with each advance in the tax rate. In only one group of cities, those with a tax of more than six cents a gallon, did this relationship fail to hold. The average price of gasoline in each tax group on September 1 is given in the accompanying table.

The lowest gasoline price in any of the 50 cities was found in Providence, Rhode Island, where the federal and state tax totals three cents a gallon; and the highest priced gasoline, 24½ cents, was found in Boise, Idaho, where a six-cent tax is in effect.

No. Cities in Group	Federal and State Tax Rate	Retail Price of Gas Including Tax
*4 Cities	*3 Cents	16 Cents
13 Cities	4 Cents	17¾ Cents
16 Cities	5 Cents	19 Cents
7 Cities	6 Cents	22 Cents
10 Cities over	6 Cents	21 Cents

*St. Louis with a 3½-cent gas tax is included in this group.

U. S. Joins War Against Tax Evasion

THREE coast guard patrol boats have been put in use by the federal government to assure enforcement of the petroleum code and to aid the states in preventing gasoline tax evasion. They supplement the work which the American Petroleum Institute's launch "Dividend" has been doing for several years.

Tax evasion by means of tank boat shipments is common. Taxes are not paid on interstate shipments until they arrive at their destination, so that it is possible to evade the tax entirely by unloading the tank boat without the knowledge of tax officials.

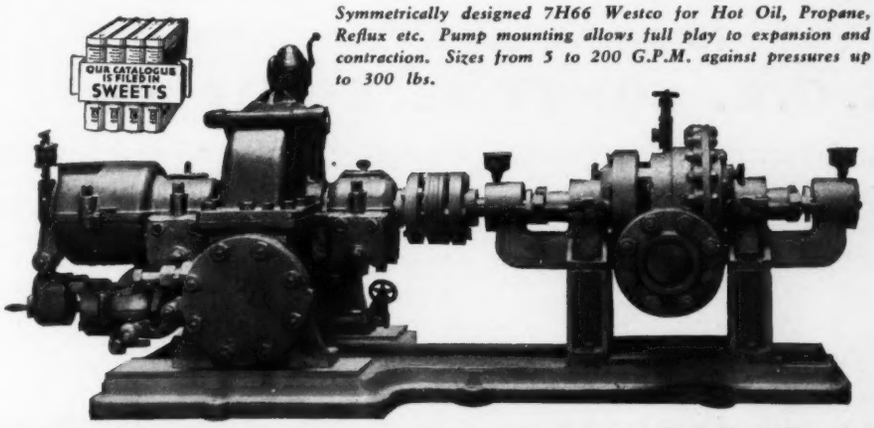
The government's three picket boats form the marine section of its Oil Enforcement Unit, operating under the Division of Investigations of the Department of the Interior.

The 36-foot picket boats, each with a crew of two men, patrol the waters of the most active ports on the Atlantic seaboard. The government men board oil tankers in port or in transit and investigate the origin and destination of their cargoes.

Under the law the masters of vessels loading petroleum or its products are required to report to the Division of Investigations of the Department of the Interior the quantity of petroleum products shipped, the kind, the date of shipment, consignee, consignor and actual destination of the cargo. A copy of this information is sent by the federal government to the tax bureau of the state to which the cargo is assigned.

If the cargo never arrives at the reported destination, the patrol boats attempt to locate the tanker and determine what actually happened to the cargo. Each time any part of the petroleum cargo is unloaded, the details covering the amount unloaded are sent in to Washington, so that one report can be checked against another.

The patrol boat service is a means of ascertaining whether the required reports have been filled out, or whether



Symmetrically designed 7H66 Westco for Hot Oil, Propane, Reflux etc. Pump mounting allows full play to expansion and contraction. Sizes from 5 to 200 G.P.M. against pressures up to 300 lbs.

INCREASE EFFICIENCY OF STABILIZER TOWERS

Do it with Westco's New, Improved Propane and Reflux Pump. Handles all light volatile liquids.

REFINERY and Natural Gasoline Plant men have always favored Westco Turbine Pumps because of their ability to *automatically adjust themselves* to changes in the operating condition. This feature enables Westcos to supply an ideal, non-pulsating feed to high pressure stabilizers which increases the efficiency of the columns by eliminating overload and underload of the stabilizer trays.

Improved Design

Now, Westco announces an improved unit with extra deep, lubricated stuffing boxes, over-size ball bearings and extra heavy shaft. These design improvements assure trouble-free performance with a minimum of maintenance expense.

SEE WESTCO'S DISPLAY HOME PLANNING HALL

1934 A CENTURY OF PROGRESS CHICAGO

Will Not Vapor Bind

Westcos are highly efficient when handling light, volatile gasoline, propane, etc., of 100° to 130° A. P. I. gravity because they will operate against pressures up to 300 lbs. per square inch without becoming vapor bound.

High Pressures in Single Stage

Westco's re-energizing pump action produces pressures which, in many cases, are 20 times greater than those produced by conventional type centrifugal pumps with the same diameter Impeller. Westcos are favorites throughout the industry for still charging and for handling Hot Oil, Fuller's Earth, Chlorine Treating Solutions, Mineral Seal Oils, Naphtha, Brine, Water, etc.

Send Coupon for Details

Send coupon below for FREE Catalog containing Performance and Selection Tables. No obligation. WESTCO PUMP CORPORATION, Davenport, Iowa. Branches: New York, Phila., Chicago, Los Angeles and San Francisco. Representatives in 50 Principal Cities.

COUPON BRINGS DETAILS

WESTCO PUMP CORPORATION, Davenport, Iowa, Dept., No. 10. *Gentlemen: Without cost or obligation, please send me your Catalog of Westco Turbine Pumps for Refinery and Nat. Gas Plant duties.*

Name .....

Address .....

City .....

State .....

WESTCO *TURBINE* PUMPS

HIGH PRESSURE - - - SINGLE STAGE

there are any other irregularities in the shipment that should be investigated.

Fred Van Covern Re-Elected

THE Planning and Coordination Committee under the Code for the Petroleum Industry September 15 announced the re-election of Fred Van Covern as assistant treasurer of the committee for the six months period from September 15. John M. Cameron was elected assistant secretary of the committee for the same period.

▼ PLANT ACTIVITIES ▼

Treating Plant: British-American Oil Company, Coutts, Alberta, is erecting a large addition to its treating plant and installing new and modern equipment. A new all-steel loading rack is also being added.

Cracking Plant: Rice Ranch Oil Company, Santa Maria, California, is completing modernization and improvement of its refinery, including addition of a Clark vapor phase cracking installation.

Purchase Plant: Phillips Petroleum Company has purchased the gasoline plant formerly operated by Bell Oil & Gas Company, in western Wheeler County, Texas Panhandle. The plant is being enlarged and a large booster station is being erected in the same area on a 40-acre site in Section 48, Block 24.

Rebuilding: Compania Nacional de Petroleo (National Oil Company), Campagna, Argentine, S. A., plans immediate rebuilding of atmospheric and vacuum distillation facilities, lines, buildings and other equipment destroyed by fire August 28. Cracking units, absorption and treating plants only slightly damaged.

Resumes: The Texas Company has resumed operations at its Cody, Wyoming, refinery, which has been shut down since 1931. The plant has a rated capacity of 3000 barrels and is equipped with a 1500-barrel Holmes-Manley cracking unit. C. J. King is superintendent.

Operating: Superior Oil Company, Elsie, Michigan, has started operating its 750-barrel skimming plant. H. J. Smith, president.

Refinery: Max Pray, Wyman, Michigan, announced late in September that he would erect a 1000-barrel skimming plant at Wyman. Pray is a former Texas refiner.

Solvent Plant: Standard Oil Company of California, at its Richmond refinery, is starting construction of a Phenol solvent refining plant.

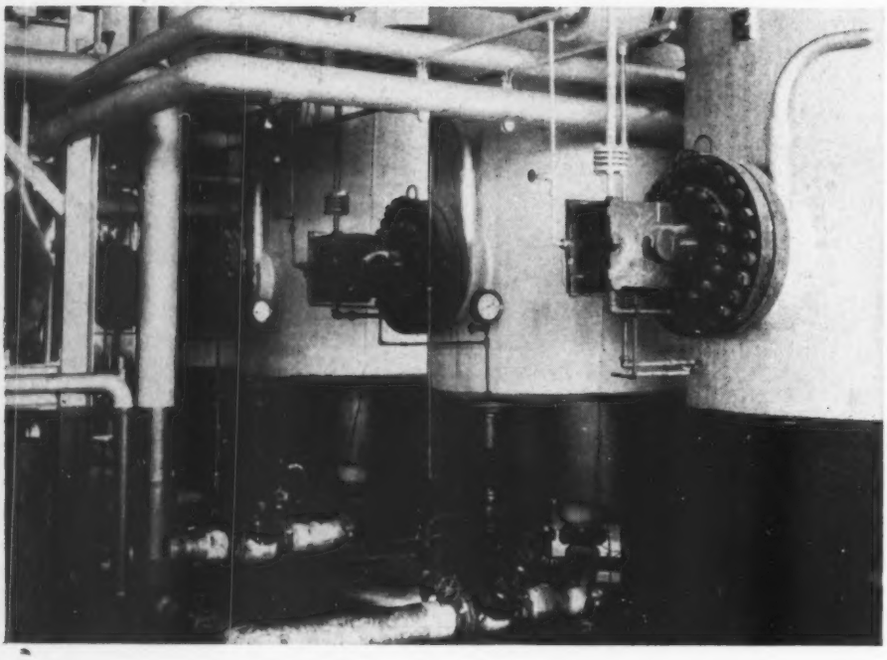
Improvements: Allegany Refiners, Inc., Bolivar, New York, is making improvements in preparing for production of a wide range of special naphthas through erection of a new 75-foot naphtha redistillation fractionating column.

Shut Down: Empire Oil & Refining Company will close down its Gainesville, Texas, refinery November 1 for an indefinite period. The plant has been in operation at 4000 barrels daily for several years. It is equipped with cracking facilities.

Refinery: Central Michigan Oil & Refining Company, St. Louis, Michigan, is erecting a small skimming plant. O.

NEW DE-WAXING PLANT USES

N. G. E. CONTROL EQUIPMENT



N. G. E. designs and manufactures a complete line of equipment for propane de-waxing and solvent extraction plant control.

When Union Oil engineers considered automatic pressure and liquid level control for their new lube oil de-waxing plant at Oleum they investigated all leading control equipment. We are proud that their final decision named N.G.E. equipment exclusively. The Union Oil Co.'s propane de-waxing plant at Oleum requires accurate liquid level control and automatic pressure control equipment. All N.G.E. equipment for the Oleum installation is specially designed. The liquid controller and motor valve have been developed to operate at low temperatures without freezing around the stuffing boxes. In this control equipment you will find a correct design, sturdy construction and careful workmanship which have characterized N.G.E. regulators and burners for the past 15 years.

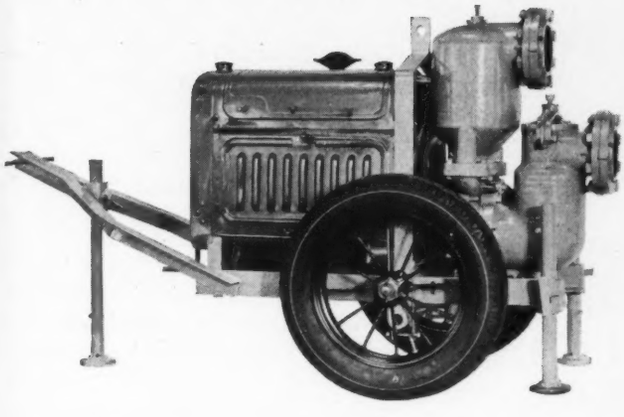
Write for detailed information on latest developments in control equipment.

NATURAL GAS EQUIPMENT INC.

Petroleum Securities Bldg., Los Angeles
1123 Harrison St., San Francisco

LOOK TO THE PIONEERS FOR CONTINUED LEADERSHIP

Wet Weather Emergencies



call for this LABOUR unit

Handling large quantities of water despite their relatively small size and light weight, LaBour portable pumps (self-priming centrifugal) are ideally suited for emergency work in and about refineries and tank farms. For emptying retention areas, for temporary drainage or flooding, for dewatering excavations—in these and countless other ways LaBour pumps are proving themselves daily in usual and unusual situations.

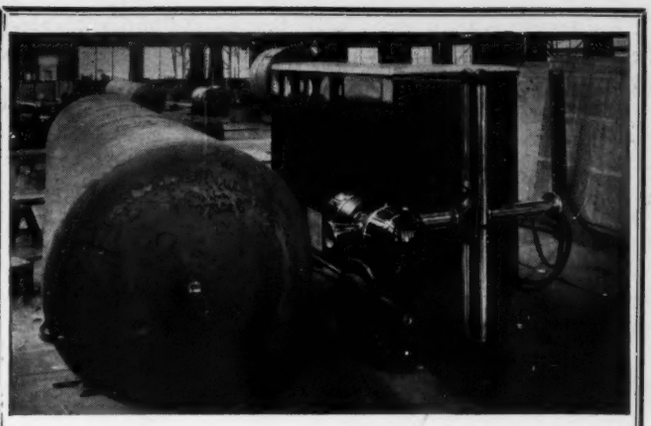
The model illustrated, for instance, weighs only a thousand pounds complete yet will lift water, by suction, twenty feet and deliver it thirty feet above the pump—all at the rate of 600 gallons a minute. Other sizes and types range in capacity from 100 gallons a minute to 1500 gallons a minute.

Send for details about these pumps. You'll find them mighty useful.

THE LABOUR COMPANY, INC.

1007 Sterling Avenue
ELKHART, INDIANA

Originators of the Self-Priming Centrifugal Pump



"EXOGRAPHS", as defined by the A.S.M.E. Code, Unfired Pressure Vessel Section, are films obtained by the use of X-rays, while those obtained by the use of gamma-rays are termed "gammagraphs", both types of film being generally termed "radiographs".

Radiographs assure the purchaser of unfired pressure vessels that the welds are free from flaws and constitute a new and important tool in the hands of the fabricator, enabling him to enhance the quality of his product.

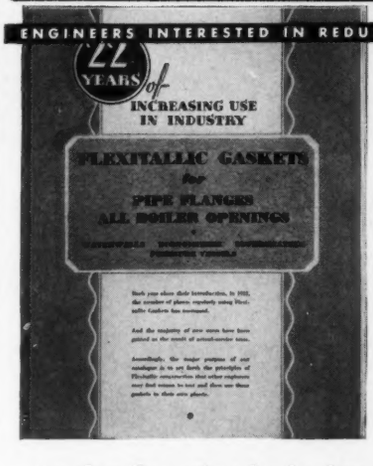
The portable industrial X-ray machine used in the Devine Shops enables us to render you this service. In addition, we are in position to render an unusual service by checking the safety factor of existing vessels in the field.

Our up-to-date facilities are at your disposal and we solicit your inquiries on Code Vessels.

Send us your inquiries

J. P. DEVINE MFG. CO., Inc.
Subsidiary of Mt. Vernon Car Mfg. Co.
MOUNT VERNON, ILL.

ENGINEERS INTERESTED IN REDUCING GASKET COSTS . . .



THIS NEW CATALOG WAS DESIGNED FOR *You!*

It describes minutely the features that reduce outages, follow-up and inspection, that prevent blow-outs and result in gaskets being able to be used not once, but several times. It tells how in the making of Flexitallic Gaskets, metal is preformed for maximum elasticity, how asbestos ribbons control compression, how the fibre is protected from erosion, how reinforcements assure the retention of mechanical elasticity, how *every feature* of Flexitallic construction contributes to the permanence of the seal. This new catalog is decidedly well worth having.

Use this handy coupon to order your copy

Please send me the new catalog for FLEXITALLIC GASKETS

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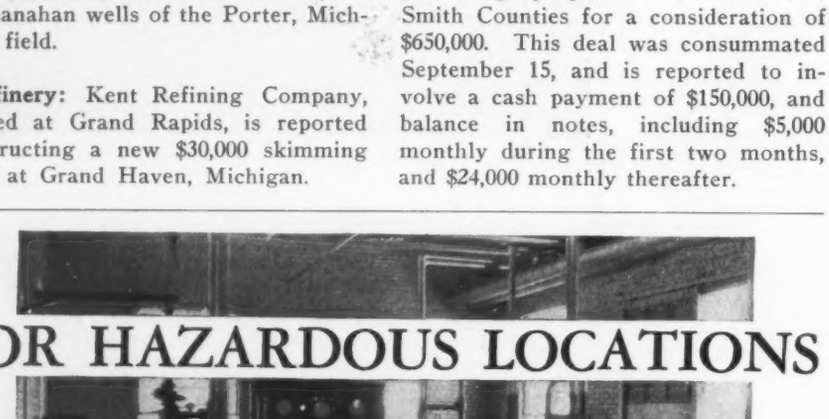
FLEXITALLIC GASKET CO., 8th and Bailey Streets, Camden, N. J.

A. Bucanning is president. I. H. Beattie of Bay City is in charge of construction.

Refinery: McClanahan Refining Company, recently organized with a capital of $125,000, is reported planning erection of a 1500-barrel refinery at Breckenridge, Wheeler, or St. Louis, Michigan, to process crude from the McClanahan wells of the Porter, Michigan, field.

Refinery: Kent Refining Company, located at Grand Rapids, is reported constructing a new $30,000 skimming plant at Grand Haven, Michigan.

Refinery: Tyler Oil & Refining Company, a new concern formed by McMurrey Brothers, East Texas producers and refiners with headquarters at Arp, Texas, has purchased Taylor Refining Company's 15,000-barrel skimming plant and 5000-barrel cracking unit at Tyler, Texas, and eight-inch trunk line connecting the plant with producing properties in Rusk and Smith Counties for a consideration of $650,000. This deal was consummated September 15, and is reported to involve a cash payment of $150,000, and balance in notes, including $5,000 monthly during the first two months, and $24,000 monthly thereafter.



FOR HAZARDOUS LOCATIONS

G-E EXPLOSION-PROOF REFINERY MOTORS

Assure Safety, Economy, Dependability

HERE are some of the reasons why G-E totally enclosed, fan-cooled motors for Class I, Group D, locations are safe, economical, and able to stay longer on the job:

Strong, reënforced housings safely withstand internal explosions

One-piece, cast-aluminum rotors, carefully ground and balanced to eliminate vibration and maintain uniform air gap

Cartridge-type ball bearings sealed in grease for protection against dust and moisture

Motor cooled by air, fan-forced through ample passageways

Underwriters' Laboratories label; motors are tested and listed for Class I, Group D, locations as defined by the National Electric Code

Write for publication GEA-1716 on explosion-proof motors and control. Address the nearest G-E office, or General Electric, Dept. 6A-201, Schenectady, N. Y.

020-6

GENERAL ELECTRIC

Natural Gasoline: Natural gasoline production in the Texas Panhandle during August was estimated at 560,525 barrels, or an increase of 30,570 barrels over the previous month. There are 50 plants in operation in the district. Phillips Petroleum Company is credited with having produced about 41 percent of the total production during August.

Carbon Black: F. C. Henderson Company, Inc., owner of a 150,000,000 cubic foot daily capacity well pressure type of absorption gasoline manufacturing plant in southern Hutchinson County, Texas Panhandle, is to erect a carbon black manufacturing plant to utilize a portion of the residue gas from the above unit. The above plant is located in the south half of Section 82, Block 46, H&TC Ry. Survey, and is stripping about 115,000,000 cubic feet of gas daily.

Natural Gasoline: Sunray Oil Company, Tulsa, proposes to proceed at once with the enlargement of its well pressure type of absorption gasoline plant in the Dumas-Sunray field, Moore County, Texas Panhandle, from 30,000,000 to 50,000,000 cubic feet of gas daily. The plant is located in Section 164, Block 3-T, T&NO Ry. Survey, and has been in operation about three years.

Refinery: Ozozo Refining Company has been formed by J. I. Staley, Wichita Falls, Texas, and associates to operate the 6000-barrel skimming plant purchased by the group early in September from East Texas Oil Refining Company at Friars Switch, located adjacent to the East Texas oil field. This plant is the first to be operated in the area. Staley, J. C. Wynne and C. A. Middleton also own Century Refining Company, which has a capacity of 2500 barrels daily, and is located at Friars Switch.

Enlarging: Utah Refining Company, Kilgore, East Texas field, has contracted for the installation of a 3500-barrel pipe still, tripling capacity of the present plant. Thomas Potter, president.

Resumes: Waggoner Refining Company, Electra, Texas, has resumed operations running on crude taken from storage at the refinery.

Operating: Gas & Oil Products, Ltd., in the South Turner Valley field, Alberta, Canada, has completed its $300,000 absorption natural gasoline plant and begun operating. A. H. Mayland, president.

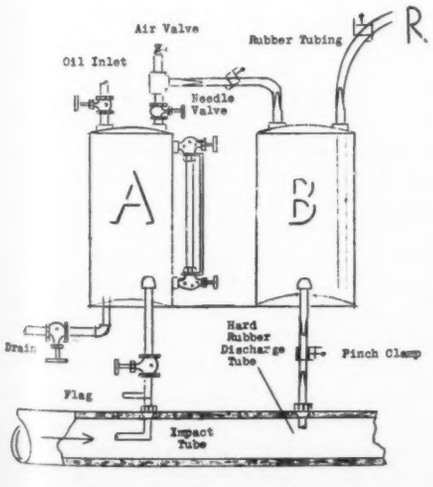
New Equipment for the Modern Plant

Solution Feeder

D. W. HAERING & COMPANY, INC.

D. W. Haering & Company, Inc., 3408 Monroe St., Chicago, announces the application of the H-O-H proportioning principles to development of a corrosive solution feeder designed primarily for feeding hypochlorite solutions. The unit is simple in construction and protected against corrosive action of the chlorine by the use of hard rubber connections and rubber lined tanks. One compartment of the feeder is filled with an inert chemical fluid lighter than the reagent and lighter than the main fluid throughout (red oil). The needle valve control is placed at such a point that it is continually filled with this inert chemical and, consequently, protected from the corrosive action of the reagent.

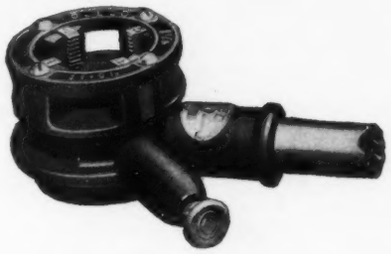
As the main fluid flows through the line a proportionate portion rises into the compartment, forcing the red oil through the needle valve and into the second compartment, displacing the reagent through a hard rubber pitot tube into the line. The machine is recharged by shutting off the connections from the pitot tubes and allowing the reagent to flow into the second compartment, forcing the red oil to return into the first compartment while the main fluid which has risen into the first compartment is drained and run into the sewer. This operation takes less than five minutes and the units are of sufficient capacities to operate for long intervals. The unit will start, stop, and vary in response to flow, being protected from corrosion, is of long life and has low maintenance cost.



Heaving Solution Feeder

Ratchet Threading Machine

THE TOLEDO PIPE THREADING MACHINE COMPANY



Toledo Threader

The Toledo Pipe Threading Machine Company, Toledo, Ohio, announces that its popular No. 11 ratchet threading tool that formerly had a capacity of one half-inch to 1¼ inches pipe, inclusive, is now offered in an increased capacity of one eighth-inch to 1¼ inches. This small compact ratchet tool has a separate die head and set of dies for each size pipe, and any combination of die heads and dies can be ordered within this range. It is an exceedingly desirable tool for close cornered jobs, as dies are changed instantly and produce smooth perfectly tapered threads.

The tool is reasonably priced and is sold by all leading supply houses.

Switch

GENERAL ELECTRIC COMPANY

General Electric Company, Schenectady, New York, has announced a compact, easily installed starting switch for use when hand operated control at the motor is required and intended for direct mounting on the built-in terminal box of standard G-E fractional horsepower motors. The device, which is mounted in a substantial steel case and is provided with a positive snap-action mechanism, is simple to install. It replaces the standard terminal box cover plate and requires no soldered connections or additional wiring. When installed the switch is so mounted that only the tumble handle extends beyond the motor profile at the side. The switch case does not project as far out from the frame as the bearing housing. It is finished in black to match the motors. The switch is of the single-pole type, rated six amperes at 125 volts or three amperes at 250 volts. It is suitable for use where overload protection is not required and where the locked rotor current of the motor need not be broken.

Fire Brick

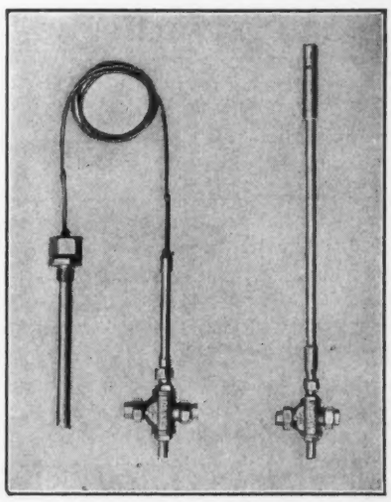
A. P. GREEN FIRE BRICK COMPANY

A. P. Green Fire Brick Company, Mexico, Missouri, announces a new line of insulating fire brick known as G-25 which the company states is scientifically controlled at every step of production. It is said to be a highly porous brick with innumerable non-communicating cells similar to the diatomaceous brick, but free from difficulties often encountered with fire brick. It is light in weight, has good spalling resistance, it is said, because of its inherent radiant qualities, reflects heat, preventing it from penetrating furnace walls. Savings in time of firing up, savings in heat losses and fuel costs are claimed for the new insulating brick. It is recommended for use in oil, gas and electric fired furnaces for temperatures up to 2500°F. where slagging or severe abrasion is not encountered.

Temperature Regulators

SARCO COMPANY, INC.

Sarco Company, Inc., 183 Madison Ave., New York, announces the addition of two new instruments to its line of self-operated temperature regulators. Type KR-15 (left) is intended for the control of brine cooling coils as used for refrigeration and cold storage. In this model the temperature-sensitive bulb is rigidly attached to the valve. The customary flexible connecting tubing is omitted. A compact and inexpensive unit is the result. As is the case on all Sarco regulators, the valve is "packless," no stuffing box is used. Frosting in service, therefore, cannot cause sticking of the valve. A key is furnished to enable the



Sarco Regulator

user to change the temperature at which the valve will hold the refrigerated space.

Type TR-20 (right). This is a new junior model of the Sarco tank regulator. It is made in three sizes, ⅜-inch, ½-inch and ¾-inch. It has a small bulb, fitted with union connection and is furnished with a short length of flexible connecting tubing.

This regulator was designed to make possible the use of automatic temperature control on equipment for which the standard regulator was too costly.

Portable Ventilator

COPPUS ENGINEERING CORPORATION

The Coppus Engineering Corporation, Worcester, Mass., has developed a new portable ventilator, used especially for removing welding fumes from enclosed compartments.

Especially designed for work being done in enclosed spaces, this unit is equally useful when welding tanks, or drums, or wherever there may be a problem of getting rid of such fumes.

The ventilator is compact in design, and can be lowered through a 14-inch diameter opening. As the total weight, including electric motor is only 80 pounds, it is readily portable and can be quickly set up and put in operation by one man.

Eight-inch diameter flexible tubing may be used to carry off the fumes and foul air at a rate of 1500 cubic feet of air per minute.

When placed in a vertical position, the ventilator rests on a ring attached to the inlet of the ventilator, so that the fumes are removed from the lowest point.

Hose

ELECTRIC HOSE & RUBBER CO.

Electric Hose & Rubber Company, Wilmington, Delaware, announces a new tank hose known as Delmar Tank Filler Hose, and the manufacturer states that it has a smooth lining of a new compound that will not crack or leak and which will not slough-off or disintegrate when used with gasoline and other petroleum products. It is said that the fact that it contains no joints or seams makes it impossible to crack unless deliberately broken, and if it is crushed the hose can be restored to shape by use of a vise or mallet. A spirally woven reenforcement of wire and cotton cords gives the hose strength and flexibility. The wire is connected to the couplings to provide positive ground for static. Standard couplings are used. The hose is used for loading and unloading tank cars, tanks, truck tanks, and for general transfer of liquid petroleum products.

Valve Controller

AUTOMATIC TEMPERATURE CONTROL COMPANY, INC.

Automatic Temperature Control Company, Inc., Philadelphia, Pennsylvania, announces Type 2, motor operated valve controller in explosion resisting housing. It is for applications which arise where motor operated valves must work in the presence of an explosive atmosphere and where it may be necessary to open the controller housing to make adjustments or to lubricate the equipment. To elimi-

Automatic Controller

nate this hazard, Type 2 controller is provided with explosion resisting housing which is divided diagonally into two flanged parts with a width of face in accordance with specifications of the Underwriters Laboratories; and the flange is machined and bolted together without a gasket, so that the force of an internal explosion would be dissipated, the resultant flame cooled and snuffed out as the gases pass out between the machined faces of the castings. The controller is supplied with a single valve for liquids or gases, or with two valves operated as a unit where fuel-air ratio must be maintained.

Bronze Bars

ALUMINUM INDUSTRIES, INC.

Aluminum Industries, Inc., Cincinnati, Ohio, has announced development of "Permite" leaded phosphor bronze bars, which the manufacturer claims is a forward stride in the production manufacture of special bearings, bushings, fittings and small parts.

These bronze bars are available in standard six-foot lengths in diameters from 5/8-inch to two inches, by 1/16-inch steps. All standard bearing bronze alloys may be supplied. The stock possesses exceptionally free machining qualities, and by using tungsten carbine tools, it has been successfully machined at speeds in excess of 1500 surface feet per minute without a coolant. A tuened finish has been adopted for these bars.

Stress Reliever

DETROIT ELECTRIC FURNACE CO.

Detroit Electric Furnace Company, 825 Elizabeth Street, West, Detroit, Michigan, announces an electric weld stress reliever for pipes ranging from six to 24 inches. The equipment has been designed for normalizing welded joints in pressure piping systems and is especially useful for field operation, in the opinion of the manufacturers.

Jointed rings of various sizes are provided to fit pipes of diameters described. Power is supplied for a special transformer which, with necessary control equipment, is mounted on a hand-truck for ease of field operation. Induction heat is applied to the areas to be relieved in accordance with predetermined values.

Speed, cleanliness and precise control are claimed as outstanding advantages for the equipment.

Motor Starter

LINCOLN ELECTRIC COMPANY

Lincoln Electric Company, Cleveland, Ohio, announces a new line of automatic motor starters, which prevents accidental starting and which permits taking full advantage of the motor's capacity without danger of burning it out. This starter is of the across-the-line type and fully meets underwriter's requirements.

It is impossible to close the starting current unintentionally due to the design of the control. The red stop button extends around and beyond the green start button. Consequently, a bump or fall against the control would move only the stop button. Once the motor is stopped, the only way it can be restarted is by pressing the recessed start button with the fingertip.

Full advantage of the motor's capacity is permitted by an inverse time limit protection which allows carrying a small overload a long time or very heavy load a short time. Immediate motor starting upon resumption of current is insured by low voltage release with two wire control.

The new starters are furnished in three types for different horsepowers and 110, 220, 440 and 550 volts. The XLA starter is for three and five-horsepower motors, 110 volts; also three, five, 7½ and 10-horsepower, 220, 440 and 550 volts. The XLB starter is for 7½ and 10-horsepower, 110 volts; 15, 20, 25 and 30-horsepower, 220 volts; 15, 20 and 25 horsepower, 440 volts; and 15 and 20 horsepower, 550 volts. The XLBB is for 30 horsepower, 440 volts; and 25 and 30 horsepower, 550 volts.

Mechanical moving parts are thoroughly reinforced and fully protected against rust by cadmium plating. Long life is assured the relay armature by a cushion action which reduces wear.

In the XLA starter surface creepage

between lines is eliminated by a one-piece barrier made of an asbestos compound properly impregnated to resist absorption of moisture and also to prevent arcing.

The internal parts of the starter are readily accessible. Moving contacts can be removed without tools. Stationary contacts can be removed by use of a screw-driver only.

The switch is easily installed and can be replaced in its entirety without disturbing the rigid conduit. A single screw holds the switch panel to the back of the case. Rigid conduit can be led into the case after it is attached to the wall.

Long contact life is assured by a wiping action which prevents pitting and in the XLB size by the cadmium plated steel shields which provide an instantaneous thermal and magnetic quench for the arcs.

Cutting Blowpipe

LINDE AIR PRODUCTS COMPANY

Linde Air Products Company, 30 East 42nd Street, New York City, has announced a new oxy-acetylene cutting blowpipe, known as Type C-34. The manufacturer claims this blowpipe incorporates into one unit several features of design and operation.

The Type C-34 was designed essentially to serve as a general duty blowpipe, but is capable of doing heavier work if necessary. Some of the outstanding features claimed for this blowpipe are new design of cutting oxygen valve, a long external cutting valve lever; nozzles with seat protectors; closer spacing of the heating orifices about the cutting oxygen opening; new nozzle sizes; interchangeable large-capacity ball-type inlet needle valves, and interchangeable low pressure injector or medium pressure mixer.

Reamer, Die Stocks

THE BORDEN COMPANY

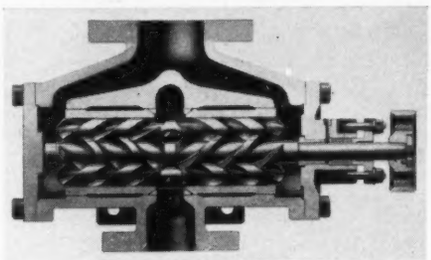
The Borden Company, Warren, Ohio, has announced addition of a number of new items to its line of pipe tools. The "Beaver" No. 200 swivel pipe reamer has been perfected, having a range from ⅛-inch to two-inch pipe. The handle and knob are made of malleable iron and are unbreakable, while the reamer head is of heat treated alloy steel, and may be resharpened many times, according to the manufacturer. When finally worn out, the reamer head can be replaced. The simple swivel action makes the tool preferable to the old style ratchet reamer, according to the manufacturer.

The company has also added "Beaver" die stocks Nos. 70 and 72, several improvements having been built into the new numbers. They are especially recommended for brass and copper pipe.

Rotary Pump

DE LAVAL STEAM TURBINE CO.

De Laval Steam Turbine Company, Trenton, New Jersey, announces development of a high speed rotary displacement pump which makes possible assembly of a compact and comparatively light weight transportable gasoline engine-driven pumping unit. The pump is called De Laval IMO, and when driven at approximately 1675 r.p.m. by a 60 horsepower gasoline engine, it delivers 90 gallons per minute against 495 pounds per square inch pressure with a suction lift equivalent



De Laval Pump

to 14 inches of mercury. The pump weighs 398 pounds and the complete portable unit with the engine, weighs about 2000 pounds. The pump has only three working parts, a central power rotor and two sealing rotors, which mesh in such a manner that the liquid is carried through, as by continuously acting piston, without shock or pulsation. There are no timing gears or separate bearings and but one stuffing box, which is subject to suction pressure only. The rotating parts are in rotational balance, and except for suction pressure against the area of the driving spindle at the stuffing box, are also in hydraulic balance axially.

Electrode

LINCOLN ELECTRIC COMPANY

Lincoln Electric Company, Cleveland, Ohio, has announced "Fleetweld No. 7," a general purpose heavily coated electrode for welding with shielded arc on mild steel. Pronounced welding economies are effected by the new electrode, according to the manufacturer.

The new electrode was particularly designed for high speed and single pass welding. It has a high burn-off rate and low splatter loss, providing fast welding at low cost, it is claimed. The electrode has a tensile strength of 70,000 to 80,000 pounds per square inch, a yield point of 55,000 to 60,000 pounds per square inch, and ductility of about 20 percent. Its resistance to corrosion is claimed to be greater than that of mild steel.

The coating is of special composition material, the metal being drawn to rigid specifications. The new electrode is manufactured in the usual run of diameters, and in 14-inch lengths. The ⅛-, 5/32-, and 3/16-inch sizes are designed for welding in flat, vertical or overhead positions, and the larger sizes for welding in flat positions only.

Carbon Holder

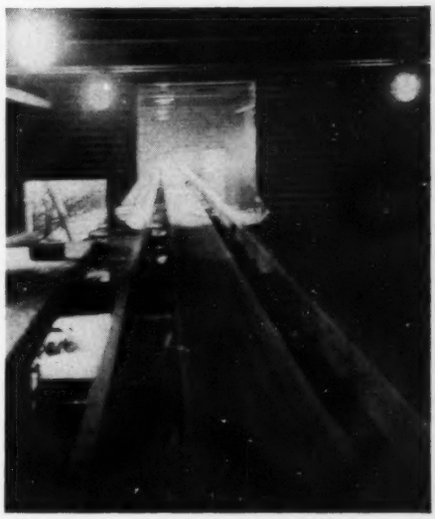
HOBART BROTHERS

Hobart Brothers, Troy, Ohio, has placed on the market a new carbon holder for carbon arc electric welding. It is so designed that water circulates not only through the handle but also around the electrode itself. The chief advantage claimed for this holder is that it is designed for use with interchangeable tips, thus making it possible to use the same holder for a wide range of carbon sizes. It is claimed that even when the carbon electrode is used at white heat for several hours, the holder itself will remain so cool that it can be touched with the bare hand at any point. The device is balanced, with a comfortable grip and with a shield of asbestos board, 5½ inches square which can be easily removed for replacement with a larger shield if desired. The entire holder is 14 inches long and weighs but 2¼ pounds.

Belt Conveyor

B. F. GOODRICH COMPANY

B. F. Goodrich Company, Akron, Ohio, announces the development of a heat resisting conveyor belt designated as Golden Ply Hot Material Belt, said to be especially useful in handling such hot and abrasive materials as fullers earths in



Goodrich Conveyor

refineries. The manufacturer claims that not only is the flexing life of the new construction in its original state 85 percent greater than that of former grades of hot material belting, but the belt cover is so constructed as to offer greater resisitance to abrasion even after prolonged exposure to heat.

Pipe Reamer

BORDEN COMPANY

Borden Company, Warren, Ohio, has developed a new swivel pipe reamer which reams one eighth to two-inch pipe. Handle and knob are made of malleable iron while the reamer is of heat treated alloy steel. It can be resharpened many times and when finally worn out, the head can be replaced at moderate cost.

Ball Seat Valves

AIR REDUCTION SALES COMPANY

Air Reduction Sales Company, Lincoln Building, New York, recently announced that it has equipped more than 96 percent of its oxygen cylinders with valves having a stainless steel ball seat. While the valve proper closely resembles the older type valve in appearance it differs in construction in that a hardened stainless steel ball forms the seat. The valves not only open and close more easily but they are said to possess better sealing qualities, and they do not corrode or score and cause leaks. For over three years similar types of hardened stainless steel ball valves have been used on all Airco DB welding and cutting torches and their use has demonstrated that torches so equipped rarely require valve repairs other than occasional renewal of valve stem packing, according to the manufacturer.

Convevor Chains

WHITNEY MANUFACTURING CO.

Whitney Manufacturing Company, Hartford, Connecticut, recently placed on the market a new line of conveyor chains which are made in four different sizes and in two types with standard and oversize rolls. According to the manufacturer the value of these chains lies in the fact that standard roller chain construction is used with an extended pitch. Attachments can be bent, welded, or riveted to meet a wide variety of requirements. All steel construction in the use of the extended pitch design provides light weight with high wear resisting qualities and strength. These conveyer chains are made in two series: 500 and 550. Both series operate over sprockets, but the use of a large diameter roll on the 550 series allows it to be employed as a drag or pressure chain, with the rollers carrying the load.

Relief Valve

TUTHILL PUMP COMPANY

Tuthill Pump Company, 131 West 63rd, Chicago, announces development of a new relief valve in six sizes with two pressure ranges.

Model V is built in sizes from ⅜ NPT to 1½ NPT for relieving pressures from five to 35 pounds. Model VH covers the same sizes for relieving pressures from 35 to 100 pounds. The only difference between Model V and Model VH is in the springs; and springs are interchangeable.

Features listed by the manufacturer include construction in the form and shape of a pipe T—reported to insure convenience of mounting; mounting in any position—to insure flexibility; spring compartment of valve vented to valve body proper to insure positive action; and construction of valve with relief pipe at right angles to inlet and outlet to simplify assembly and insure economy of mounting as well as provide freedom from chip-clogging. Replacements are simplified as many parts are common to more than one size.

Blowpipe Valve

LINDE AIR PRODUCTS COMPANY

Linde Air Products Company, New York City, is offering a new type of needle valve for use on "Oxweld" blowpipes. The new valve is the ball-seat needle type, and is claimed to be a decided improvement over the old type. It is interchangeable on all blowpipes now in service.

Diesel Engine

FAIRBANKS, MORSE & COMPANY

Fairbanks, Morse & Company, Chicago, has announced a new light weight opposed piston Diessel engine which embodies several interesting features. The engine is being shown for the first time at the company's Century of Progress exhibit at Chicago. Light weight and reduced space requirements have been achieved through improved design.

The weight has been brought down to 20 pounds per horse power, while improved scavenging and a greater virtual stroke-bore ratio has resulted in improved combustion efficiency. The construction has been simplified by a substantial reduction in the number of parts and complications otherwise imposed by a multiplicity of parts has been eliminated.

While these engines are designed primarily for installations where weight and space are an important factor such as for marine and mobile equipment they are adaptable for stationary work.

Engines of the opposed piston type are inherently balanced because the reaction forces of the two pistons in the cylinder oppose and tend to counteract each other. This leads to higher rotative and piston speeds with a consequent reduction in weight.

Several important design features increase the effectiveness of this engine. It has two short, large diameter crank shafts with a synchronizing connection which makes for compactness. The control features are unusual, as for the first time the three functions of regulating injection timing, pressure and quantity are centered in a single lever. Response is rapid and accurate and the engine may be changed from idling to full speed in only a few revolutions or maintained indefinitely at any intermediate speed within very narrow limits.

The elimination of cylinder heads by confining the combustion space between the two pistons not only improves combustion but also allows better cooling facilities at this point as well as eliminating the necessity for gaskets. The frame is of rigid light weight construction which together with the use of aluminum for parts not subjected to stress, such as cover plates, etc., makes for light weight with no reduction in strength. Built-in duplex rotary scavenger blowers are provided and the uniflow principle of scavenging is employed. Other built-in auxiliaries include lubricating oil pumps, fuel oil service and transfer pumps and circulating water pumps.

These engines are available in five cylinder sizes, five by six, 6½ by eight, eight by 10, 10 by 12 and 12 by 15 inches, and in six, seven and eight cylinder combinations with a five cylinder size in the smallest bore. Power capacities range from 50 to 300 horse power per cylinder, or for the engine, from 250 to 2400 horse power.

Hose Joint

B. F. GOODRICH RUBBER COMPANY

B. F. Goodrich Rubber Company, Akron, Ohio, is offering a new patented hose joint which eliminates all contact between metal and fluid. The manufacturer claims the construction permits greater flexibility than other type of coupling or joint, and affords an effective seal in suction and discharge service up to 125 pounds working pressure.

The "Flexseal" joint was designed particularly as a substitute for nipples and flanges. It is recommended for the larger diameters of suction or discharge hose handling acid or corrosive liquids.

Success of the joint is dependent upon the unique end built into the hose, according to the manufacturer. This end consists of an enlargement, or bead, reinforced with numerous plies of fabric surrounding a rigid steel ring of angular cross section. The joint is assembled with the aid of split flanges and standard bolts. Joint sizes range from 1½ inches up.

Items About Manufacturers

WILLIAM C. DREYER

Dreyer Locates In St. Louis

Effective October 1, W. C. Dreyer, petroleum engineer, will be located in the southwestern district of the Westinghouse Electric and Manufacturing Company with headquarters in St. Louis, thereby making available specialized engineering services for the West Texas, Mid-Continent and Gulf Coast oil fields.

William ("Bill") C. Dreyer attended the Glendale Union High School, Glendale, California, and graduated from the California Institute of Technology in 1924 with a B.S. in Electrical Engineering. Leaving college he entered the Graduate Student Course of the Westinghouse Electric and Manufacturing Company at East Pittsburgh. Upon its completion he became an industrial engineer for that company, working on pumping and drilling equipment for oil wells, pipe line pumping and refinery electrification.

With his many years of field and headquarters experience, Dreyer is exceptionally well qualified for his new work.

D. W. Haering & Company, Inc., 3408 Monroe St., Chicago, manufacturers of H-O-H water treatments and proportioning units, announce appointment of D. D. Morey, formerly of Morey & Morey, Dallas, Texas, as district manager in the New York office at 1451 Broadway.

J. C. Lincoln Awarded Samuel Wylie Miller Medal

The American Welding Society on October 1, awarded the Samuel Wylie Miller medal to John Cromwell Lincoln, chairman of the board, The Lincoln Electric Company, Cleveland, Ohio, in recognition of his great contributions to the advancement of the science of electric fusion welding.

As one of the early pioneers of arc welding, J. C. Lincoln has devoted most of his life to research and development of the electric arc as an industrial tool.

Born July 17, 1866, in Painesville, Ohio, J. C. Lincoln received his elementary education in the place of his birth, after which he attended Ohio State University, and received a degree in electrical engineering.

Joining the staff of Charles F. Brush, inventor of the arc light, in 1888, Lincoln early gained experience with the phenomena of the electric arc. Later he became affiliated with Elliott-Lincoln Electric Company, one of the pioneer manufacturers of electric motors. In 1896 with this company as a nucleus, he formed the present Lincoln Electric Company, Cleveland, Ohio.

Under his direction this company produced in 1907 the first variable voltage arc welding machine. Two years later as a direct result of Lincoln's efforts, the first redesign of a cast iron product for arc welded steel construction was made.

In 1916 Mr. Lincoln was the first to

J. C. LINCOLN

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carry the electric arc into the structural field, where he directed the application of the process in the remodeling of an industrial structure.

A year later in conjunction with the United States government, he established the first school for training welding operators.

What is considered the greatest single advance in the art of welding was effected under Mr. Lincoln's direction in 1929 when his company introduced the first practical shielded arc for general industrial use.

Since he introduced the first variable voltage arc welding machine for the repair of faulty castings, J. C. Lincoln has seen the results of his numerous inventions in this field achieve a prominent position in the fabrication and maintenance of metal products.

J. H. Fisher, president Fisher Governor Company, Marshalltown, Iowa, made a trip through the Mid-Continent and Gulf Coast oil country during September.

W. T. Davidson has been appointed manager of the machine parts division of Struthers-Wells Company, Warren, Pennsylvania. This enlarged division of Struthers-Wells activities is playing a prominent part in the development of equipment through the use of welded plate and alloy to replace castings in machine design, etc. Mr. Davidson has been with Struthers-Wells Company many years and for several years has been in charge of development, research and other technical activities.

W. T. DAVIDSON

Worthington Pump & Machinery Corporation, Harrison, New Jersey, has announced the retirement of Henry M. Chase, who entered the engineering department of the Holyoke works of the company (then the Dean Steam Pump Company) on June 17, 1891. With the exception of one year spent with the De La Vergne Manufacturing Company, he has been continuously identified with Worthington up to the time of his recent resignation.

As detail draftsman, designer, field and shop test engineer, research engineer, estimator, chief draftsman, chief engineer and consulting engineer, he covered practically the whole line of the Holyoke works. He invented and patented a number of improvements in pumping machinery. He graduated from Massachusetts Institute of Technology in 1891, and was for many years a member of the American Society of Mechanical Engineers. He will retire to his home town, Holyoke, Massachusetts.

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